varian chromatography training

PESTICIDES
RESIDUES LAB
Room 229

MAINTENANCE AND TROUBLESHOOTING OF THE 6000 G.C.

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MAINTENANCE OF THE GAS CHROMATOGRAPH
PROGRAM

Day 1

8:45 - 9:00	Introduction to Course
9:00 - 10:00	Chromatographic Troubleshooting Lecture I
10:00 - 10:15	Coffee
10:15 - 11:00	Chromatographic Troubleshooting Lecture II
11:00 - 12:15	Chromatographic Troubleshooting Laboratory I -leak, noise and background check -run standard sample for control check
12:15 - 1:00	Lunch
1:00 - 4:30	Chromatographic Troubleshooting Laboratory II

Instrument #1

Problems Found	Method of Correction

Instrument #2

Problems Found	Method of Correction

Instrument #3

Problems Found	Method of Correction

Instrument #4

Problems Found	Method of Correction

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Day 2

9:00	- 10:00	Electronic, Electrical Troubleshooting Lecture I
10:00	- 10:15	Coffee
10:15	- 11:00	Electronic, Electrical Troubleshooting Lecture II
11:00	- 12:15	Electronic, Electrical Troubleshooting Instrument #1

Problems Found	Method of Correction
_____	_____
_____	_____
_____	_____
_____	_____

12:15 - 1:00 Lunch

Electronic, Electrical Troubleshooting Instrument #2

Problems Found	Method of Correction
_____	_____
_____	_____
_____	_____
_____	_____

Electronic, Electrical Troubleshooting Instrument #3

Problems Found	Method of Correction
_____	_____
_____	_____
_____	_____
_____	_____

Electronic, Electrical Troubleshooting Instrument #4

Problems Found	Method of Correction
_____	_____
_____	_____
_____	_____
_____	_____

Review and Final Discussion

varian

MAINTENANCE OF THE

6000

GAS CHROMATOGRAPH

TABLE OF CONTENTS

SECTION 1.....INTRODUCTION

SECTION 2.....ROUTINE MAINTENANCE

SECTION 3.....CHROMATOGRAPHIC TROUBLE-SHOOTING AND SERVICE

SECTION 4.....ELECTRICAL AND ELECTRONIC TROUBLESHOOTING AND SERVICE

APPENDIX

SECTION 1
INTRODUCTION

1.1 INTRODUCTION

The information and procedures compiled in this manual focus on two major areas of possible problems with a 6000 **Gas Chromatograph**: the chromatographic pneumatics and the chromatographic electrical. An experienced chromatographer will be able to use these details to perform a comprehensive job of troubleshooting, service, and preventive maintenance.

Practical exerience has shown that a great many chromatographic operating difficulties or failures occur because of a simple oversight of a basic requirement for normal operation. For this reason, the manual has been organized to guide the troubleshooter with an outline starting from simple diagnostic procedures that eliminate the basic causes of malfunction, to the solution of progressively more complex problems requiring more sophisticated procedures.

The manual is divided into 4 broadly inclusive sections:
Section 1 — Introduction
Section 2 — Routine Maintenance (Including operating check list)
Section 3 — Chromatographic troubleshooting and service
Section 4 — Electrical and Electronic troubleshooting and service

Section 2 includes the basic continuing and preventative maintenance required to keep the instrument in normal working order. This section also includes a "Quicky Check List" that is recommended as a standard start up and initial troubleshooting procedure.

Section 3 describes system malfunctions that result in abnormal responses in the chromatogram. A diagnostic table is presented showing detector response characteristics, their suggested causes, and recommended remedies.

Section 4 lists the causes, symptoms, and tests for electrical or electronic failures. This section describes the common failures, their probable causes, and suggested corrective measures. Procedures for isolating circuitry failures at the PC Board level are described. Instructions for locating and replacing blown fuses, locating shorted or loose connections, and location and measuring of test points are included. It is assumed that the operator or technician performing these tasks will have a good understanding in the use of the volt/ohmmeter.

Appendix. Procedures for logic checking, column conditioning, syringe loading, etc. are filed in this portion of the manual. Use this section for filing related information and any forthcoming publications that may be added to this manual.

WARNING: Procedures outlined in this manual require testing in the power-up mode with protective panels removed. Hazardous voltages are exposed. Those with experience and background should perform these tests.

SECTION 2
ROUTINE MAINTENANCE

2.1 GENERAL

Several routine maintenance procedures should be regularly scheduled and performed to insure continued high performance of your instrument. The frequency of checks is highly dependent upon the daily usage of the instrument, therefore, a fixed periodic schedule is not necessarily applicable. The following measures should be undertaken when instrument performance dictates the need.

2.1.1 Quicky Check List

The following tabulated check list provides a rapid diagnostic procedure for locating a specific cause contributing to an instrument operating failure or malfunction either at start up, or during an analysis. Basic oversights or omissions of fundamental operating necessities are covered and the kind of checks that should not take longer than 2 minutes to complete.

Function Check	Key Indicator	Discussion
Power	Power cord	Cord not plugged in. Faulty contact.
	Power light off	Power button out.
Pressure	Col. head pressure, Hydrogen, Air pressure (FID, FPD)	Check all cylinder and regulator valves. Check gauges and valves on pneumatics control panel.
Heat zones	Column, Injector, Detector	Check set points against actual temperatures on R/O. Check Col oven switch should be set to HTR&FAN.
Detectors	FID flame lit	Check for H_2O condensation, Check R/O flame ESP.
	TCD current	Check TCD fil current on R/O. Check reset indicator.
Signal output	Mode switch, Attenuation, Range, Polarity	Check switches for settings appropriate for the analysis.
Sample	Syringe loading	Check syringe barrel for bubble free liquid column. Check for obvious liquid leaks around needle seal and plunger.

If this quick check fails to identify and locate the malfunction, refer to sections 3 and 4 for detailed troubleshooting procedures.

2.2 SEPTUM REPLACEMENT

The injector septum is expected to perform the most exacting requirements of any component in the chromatograph. It must operate continuously bleed free at elevated temperatures (200-400°C); it must operate continuously leak free at elevated pressures (20-60 psig); and it must operate with repetitive punctures from the syringe needle. It is not surprising that septum replacement represents the major part of the chromatographic routine maintenance.

Excessive septum damage from the needle penetrations can be avoided by injecting into the same location, eliminating any burrs that may develope on the needle point, and using smaller diameter needles when possible.

It is not uncommon to obtain several hundred injections from a good quality septum, operated at modest temperatures and pressures, and injected with an AutoSampler. The symptoms of the septum overdue for replacement are changes from the expected results i.e., decreased sensitivity, increased R.T., increase in baseline instability; and deterioration of peak shape.

The inlet (injection) end of the injector body is designed with a beveled septum cutting edge. The sharp edge cuts partially into the septum providing a secure seal with moderate pressure on the septum nut. The cutting edge should always be free of any adhering material from the old septum to ensure a good seal. Generally the septum will separate freely, remaining in the septum nut and leaving the injector cutting edge clean.

When installing a new septum review installation instructions specific to the septum being used. Some sandwich types, and those coated on one side with a PTFE film require specific orientation with respect to the column, i.e., PTFE against carrier gas. In general, most standard type septa may be installed with either face toward the column.

Replace septum as follows:
(1) Best time is last thing of the day or week so that down time is minimized due to septum equilibration or bakeout.

(2) Remove injector cover and septum nut. If a pressure controller carrier flow is being used as with capillary application the carrier gas should be shut off to preserve the supply.

WARNING: Septum nuts may be hot enough to seriously burn skin. Use protective gloves to protect the hands from burns.

(3) Remove old septum from nut with a sharp pointed probe using care not to scratch or otherwise damage interior threads of nut. If septum adheres to injector body, remove it with a pair of tweezers, again using care to avoid marring or scratching cutting edge surfaces. If present, carefully remove residue fragments of old septum from both nut and injector body inlet.

(4) Install a preconditioned* septum which is particularly important for temperature program application and high detectivity requirements. Be sure to follow instructions for specific septum being installed. Seat new septum evenly in nut making certain it is not cocked or hung up on the threads.

(5) Screw nut onto injector body until resistance indicates that septum and cutting edge have met. Turn nut an additional half turn to partially cut into the septum and make the seal.

(6) Replace injector cover.

(7) For best septum life expectancy and minimum septum bleed operate the injector only slightly hotter than the column (typically 25°C for most analytical applications).

2.3 COLUMN RECONDITIONING

Column conditioning, or column bakeout as it is referred to by some is required when column efficiency begins to fall off, i.e., loss of resolution, peak tailing, severely drifting baseline, elution of extra peaks, etc.

A generally applicable technique for conditioning packed or capillary columns is not practical since published data on maximum temperatures for liquid phases varies a great deal depending upon the distributor.

Adequate conditioning parameters are most accurately determined through experience and observation. Obviously care must be taken to avoid "over cooking" the column, and boiling off the liquid phase, thus rendering the column useless. Some generally accepted procedures are listed below. These are presented as a guide rather than as specific recommendations.

2.3.1 Packed Column Conditioning

(1) From published data, ascertain the maximum isothermal operating temperature of your column. See Appendix E.

(2) Set carrier gas flow to 20-30 ml/min for 2 mm i.d. columns and 50-60 ml/min for 4 mm i.d. columns.

(3) Disconnect the column exit from the detector inlet fitting, to avoid detector contamination. This is particularly important for new columns and electron capture detectors.

(4) Adjust oven temperature to 25-30°C below the temperature found in Step 1 above. Close oven door and allow column to bakeout for 16 hours (overnight). If the column is attached to the detector the column stability can be monitored by the background current.

2.3.2 Capillary Column Conditioning

The following instructions apply only to glass capillary columns sold by Varian Aerograph. For conditioning conditions on other than Varian columns, follow the supplier's recommendations:

All Varian Glass Capillary Columns are shipped with a computer generated data sheet giving all specifications associated with the column.

All Varian Glass Capillary Columns are conditioned at the factory prior to shipment: Both isothermal and programmed maximum operating temperatures are given on the data sheet in addition to the conditions under which the column was initially treated.

*See septum conditioning procedure

Varian Glass Capillary Columns are initially conditioned at maximum isothermal operating temperature.

When it becomes necessary to recondition a Varian Glass Capillary Column refer to the data sheet that was shipped with the column in question.

The column should be conditioned at the above temperature until baseline offset is less than 30% full scale at 16 x 10^{-12}A.

NOTE: Glass capillary columns must be disconnected from the detector inlet fitting during the conditioning period.

2.4 DETECTOR CELL REFURBISHING

A contaminated cell may be indicated by one more detector responses, i.e., loss of sensitivity, noise, peak assymetry, etc. Often, simple cleaning procedures can correct the defect. These paragraphs give some of these procedures. When more complex procedures are required, consult the appropriate detector manual or call a Varian service representative.

2.4.1 Flame Ionization Detector (FID)

A. Detector tower assembly cleaning.

(1) Remove detector tower assembly (for detailed removal instructions, see Figure 2-1).

(2) Scrape contaminants, e.g., SiO_2, etc., from bore of the collector tube and upper and lower insulators.

(3) Flush components with clean methanol and air dry.

(4) Wipe off detector tower with acetone.

(5) Clean probe arms with methanol and dry in air or air oven (maximum drying temperature of 150°C).

(6) Reassemble.

B. Flame tip cleaning and ferrule replacement.

(1) Unscrew flame tip from detector base.

(2) Clear flame tip bore by passing .08" wire through it.

(3) Inspect ferrule for cracks or severe distortion.

(4) Install new ferrule if necessary
   (a) Vespel for operating temperatures less than 350°C.
   (b) Graphite with metal backing ferrule for temperatures above 350°C.

C. Flame Sensor adjustment

Failure of flameout/reignite or ESP flame indicator may be due to misalignment of flame sensing thermocouples at the flame tip. Check alignment and adjust as follows:

(1) Turn off the gas supplies to the detector.

(2) Remove the snap-on detector cover.

(3) Remove the top hold down clip, signal probe, upper insulator, collector tube, and lower insulator from the detector.

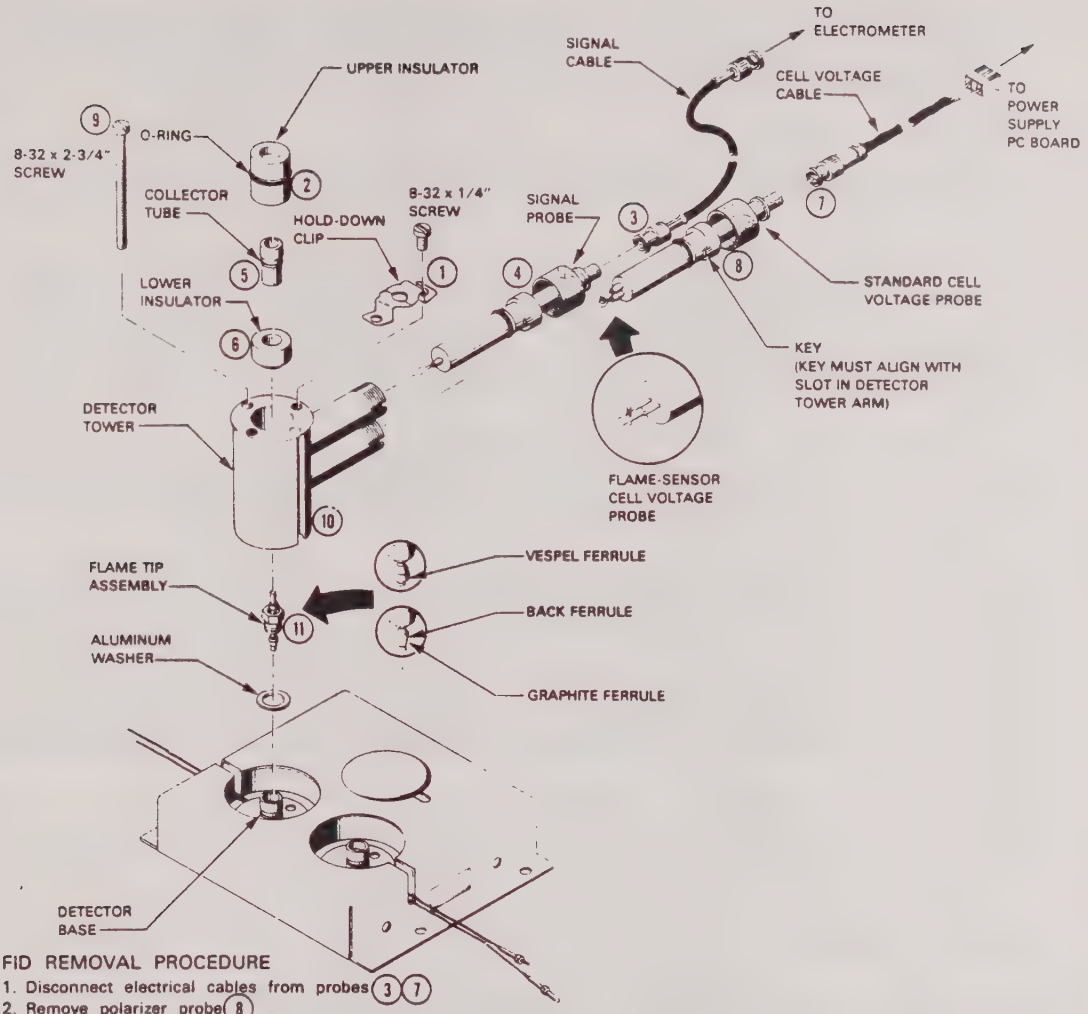


FIGURE 2-1 FID EXPLODED VIEW

FID REMOVAL PROCEDURE

1. Disconnect electrical cables from probes (3) (7)
2. Remove polarizer probe (8)
3. Remove hold down screws (9)
4. Lift off tower (10)

PRESSURE LEAK CHECK

1. Remove flame jet (11)
2. Install blank off plug
3. Pressurize to 60 psig
4. Seal off H_2, Air, Carrier Gas
5. Wait 15 min for pressure drop

POLARIZATION CHECK #1

1. Measure voltage at female pin +250 Vdc

FID REINSTALLATION PROCEDURE

1. Install flame jet (check ferrule don't over tighten ferrules, inspect for cracks)
2. Install tower, screws
3. Remove collector electrode (4)
4. Remove hold down clip (1)
5. Remove upper insulator, collector tube, lower insulator (2) (5) (6)
6. Install polarizer probe (watching to see that clip slips around jet) (8)
7. Connect polarizer cable (7)

POLARIZATION CHECK #2

1. Measure voltage by touching VOM probe on flame jet
2. Finish reassembly

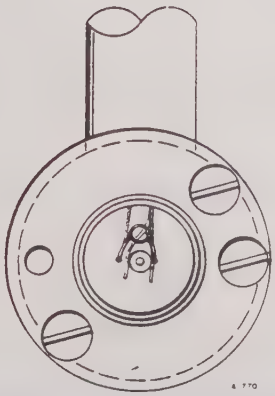


FIGURE 2-2 ORIENTATION OF FLAME SENSOR THERMOCOUPLE

(4) Observe the orientation of the flame-sensor elements by looking down through the top of the detector tower. The orientation of the flame-sensor elements should be the same as that shown in Figure 2-2. Use needle-nose pliers to adjust thermocouple leads.

(5) Reassemble detector.

(6) Install new aluminum washer between tower and detector base and install tower assembly.

2.4.2 Thermal Conductivity Detector (TCD) Cleaning

TCD filaments may become desensitized by accumulated coating of contaminants. Sensitivity may be restored by flushing through several microliters of acetone. If this preliminary procedure does not correct the problem the entire detector assembly must be replaced. Do not attempt to dismantle the detector oven assembly. Notify your Varian service center.

2.4.3 Electron Capture Detector (ECD) Cleaning

In many cases, compounds deposited on the radioactive foil or cell ceramic insulators can be removed by vaporization in an elevated temperature. Addition of H_2 gas to the carrier gas, though more difficult to set up, provides faster and more complete cleaning

CAUTION: If, in addition to the ECD, there is an FID with a Vespel® ferrule on the flame jet in either channel of the 6000 GC, the ferrule must be removed or the Vespel ferrule must be replaced with a graphite ferrule before the detector oven temperature is raised above the 350°C.

NOTE: Safety circuitry will cause the main instrument power to shut down if the detector oven temperature exceeds approximately 430°C (radioactive-source temperature 400°).

A. Thermal Cleaning With Carrier Gas

For thermal cleaning using N_2 or Ar/CH_4 carrier gas, use the following procedure:

(1) With carrier gas flowing through the ECD cell, increase the ionization detector oven temperature to 420°C.

WARNING: Maximum permissible operating temperature of the radioactive foil is 400°C, which is not exceeded at the maximum detector oven temperature if carrier gas is flowing. Be sure carrier gas is flowing through the detector cell before setting the detector oven temperature above 400°C.

(2) Monitor the base frequency (f_0) magnitude on a recorder while the ionization detector oven heats to its maximum temperature. The f_0 will show an initial increase in magnitude, then a gradual decrease as chemical contaminants vaporize.

(3) Allow the detector oven to remain at 420°C until f_0 has reached a stable, unchanging level. A stable f_0 value is an indication that the foil has been cleaned as much as it can by this method.

(4) Reduce the ionization detector oven temperature to the desired operating tempeature.

B. Thermal Cleaning With Hydrogen

For thermal cleaning using H_2 gas as a purging agent:

(1) Plumb in H_2 gas to the ECD by way of the rear panel H_2 inlet and the H_2/Air block.

(2) Set the carrier gas flow through the column to 20 ml/min and set the H_2 flow to 50 ml/min.

(3) Monitor the base frequency (f_0) magnitude on a recorder and increase the ionization detector oven temperature to 420°C.

(4) Allow the detector-oven temperature to remain at 420°C for 30 minutes or until f_0 reaches a stable level.

(5) Shut off the H_2 flow and disconnect the H_2 supply from the rear panel fitting, then connect a carrier gas supply to the H_2 inlet.

(6) Open the H_2 valve and purge the line with carrier gas for 5 minutes to remove any residual H_2 gas, then shut the valve and disconnect the carrier supply from the H_2 inlet.

(7) Cool the ionization detector oven temperature to the desired operating temperature, reinstate the normal carrier gas flow rate, and reset other controls for the desired operating conditions.

2.4.4 Flame Photometric Detector (FPD) Servicing

Since the FPD cleaning procedure comprises so many parts, the entire service section of the FPD Manual (Publication No. 85-001139-23) is included here.

The following procedures are intended to aid the operator in maintaining and repairing the FPD, and to serve as a guide when changing detector types.

A. Detector Removal/Disassembly

The FPD may be removed and/or disassembled by the operator for inspection, cleaning, and/or parts replacement. To remove the entire detector assembly (excluding the FPD adapter plate) for access to the flame tips or as a preliminary step to disassembly, proceed as follows:

(1) Turn off the hydrogen and air supplies to the detector at the pneumatics control panel. The carrier gas should be left on to prevent back-diffusion of air and moisture into the column while the detector is out of the instrument.

(2) Turn off the detector-oven and column-oven heaters. If the GC is at operating temperature leave the cooling fan on for approximately 15 minutes to allow the detector to cool.

(3) When the instrument has cooled sufficiently, turn off power to the detector with the FPD Controller POWER OFF pushbutton switch. (Power to other detectors may be left on.)

WARNING: To avoid burn and/or shock hazards, be sure the FPD is cool and the power is off before removing the detector.

(4) Remove the snap-on detector from the top of the GC.

(5) Disconnect the high-voltage cable, then the signal cable from the PMT housing, and disconnect the ignitor cable from the detector tower. (The high-voltage and signal cables are identified on the WARNING label on the top of the PMT housing.)

(6) Remove the two long screws holding the detector tower to the FPD adapter plate and lift the entire detector assembly from the GC. This exposes the flame tip assembly.

(7) Remove the flame tips, if desired, but do not loosen the adapter plate unless it is to be removed from the instrument (e.g., for installing a different type of detector).

(8) Disassembly of the detector for most operator needs is shown in Figure 2-3. Specific disassembly procedures for cleaning the tower and optical components and for replacing the PMT and ignitor are described in subsections of paragraph 2.4.4 D. Removal of the optical filter assembly is covered in paragraph 3.6 of the FPD/FPD Controller (Publication No. 85-001139-23).

B FPD Adapter Removal/Reinstallation

It is not normally necessary or desirable to remove the FPD adapter plate from the detector base unless the FPD is to be replaced by another type of detector.

NOTE: Whenever the adapter plate is loosened, or removed and reinstalled, the aluminum washer between the detector base and the adapter plate must be replaced. Failure to do so may cause leakage with a resulting loss in chromatography reproducibility. Spare aluminum washers are available as Part No. 15-000347-00.

To remove the adapter plate:

(1) Remove the right and left top cabinet covers from the GC.

(2) Remove the flame tips from the detector base if they have not already been removed

(3) Remove the two screws holding the adapter plate to the detector base (see Figure 2-3), then lift the adapter plate and the aluminum washer from the detector base.

(4) If the adapter plate is to be taken out of the GC, remove the side panel from the pneumatics cabinet, disconnect the Air #2 line from the makeup valve, and guide the tubing out of the instrument.

CAUTION: Be careful not to damage the O-rings when removing and installing the cartridges. Scored O-rings can cause gas leakage or erratic gas low. Replacement O-rings can be ordered as P/N 27-402302-00 (larger O-rings) and P/N 27-402830-00 (smaller O-rings).

NOTE: Even a small amount of hydrogen leakage into the ECD will cause a noisy baseline.

To reinstall the adapter plate, assuming the GC is equipped with an appropriate "makeup" valve (P/N 57-000291-00), with black knob:

(1) Check the detector base and adapter plate for cleanliness. These surfaces must be free of dust and insulation debris to provide good metal-to-metal contact.

(2) Place a new aluminum washer on the shoulder of the detector base. The #2 flame tip may be loosely installed to aid in centering the adapter plate, or both flame tips may be installed at this time, if desired, as described in paragraph 2.4.4 C.

(3) Place the adapter plate over the flame tip, orienting the plate so the gas line passes through the slot in the side of the detector oven cover. Secure the adapter plate to the detector base with the two 8-32 x 5/8" screws, alternately tightening the two screws. NOTE: if the adapter plate is installed before the flame tips, do not tighten the adapter plate screws until the #2 flame tip has been screwed into the detector base.

(4) Position the gas line from the adapter plate alongside the two lines from the detector base and lead the gas line into the pneumatics cabinet.

(5) Connect the end of the gas line coming from the adapter plate to one of the outlet ports of the "makeup" valve. (The other outlet port should be blocked with a port plug and O-ring.)

(6) Reinstall the side panel of the pneumatics cabinet.

(7) Before installing the detector on the adapter plate, measure the carrier gas flow out of the flame tip. This measurement will be used for a leak check of the seal at the aluminum washer after the detector has been installed.

C. Detector Reassembly/Reinstallation

Reassembly of the FPD is described in appropriate subsections of 2.4.4 starting with D. With the FPD adapter plate installed as described in paragraph 2.4.4 B and the detector completely assembled, reinstall the FPD as follows:

WARNING: Before reinstalling the FPD, make sure the detector power is off.

(1) If the flame tips are removed without removing or loosening the adapter plate, insert the #1 flame tip, with attached ferrule, through the adapter plate into the detector base. Next, install the ferrule-backing washer and #2 flame tip (see Figure 2-3). If, for some reason the ferrule is to be replaced it is recommended that the #1 flame tip also be replaced. In this case, the #1 flame tip should be inserted as far as it will go into the detector base, then the ferrule should be placed down over the #1 flame tip, followed by the ferrule-backing washer and the #2 flame tip. Tighten the #2 flame tip finger-tight, then an additonal 1/8 to 1/16-turn with a wrench. CAUTION: Do not overtighten the flame tip, as this will compress the ferrule into the detector base and #1 flame tip and may damage those components.

(2) Check the adapter plate O-ring for deterioration and replace if necessary (see paragraph 2.4.4 F).

(3) Place the detector on the adapter plate, and the top plate on the detector tower, then insert the two 8-32 x 2-3/4" mounting screws. Secure the detector to the adapter plate by alternately tightening the two screws.

(4) Check the orientation of the ignitor in the detector tower (flameout/reignite option only). If incorrect, remove the ignitor, then retape and reinstall it in the detector tower, as described in paragraph 2.4.4 H.

(5) Connect the signal, high-voltage and ignitor cables to the detector. Connectors J2 and J5, the signal and high-voltage cable connections, are identified on the WARNING label on the top of the PMT housing. The high-voltage cable (labeled "H.V.") can be identified by the long insulator around the connector center conductor.

(6) Readjust the gas flows. If the instrument is equipped with the flameout/reignite option, check the flame monitor threshold adjustment as given in paragraph 2.4.4H. The carrier gas flow measurement should be within 10% of the value obtained at the flame tip in paragraph 2.4.4 D. If not, the seal at the aluminum washer is probably leaking. (Check that the adapter plate is tight; replace the aluminum washer if necessary.)

(7) After ensuring that the detector seal is satisfactory, reinstall the GC top cabinet covers (if removed) and the snap-on detector cover.

D. Detector Cleaning

During normal operation of the FPD, there is very little buildup of contaminants (e.g., SiO_2) inside the detector tower. Even a heavy accumulation of contaminants will not affect the performance of the detector, except for a possible loss of light transmission through the tower window (see paragraph 2.4.4 E). If a buildup is found while other maintenance is being performed on the detector, it may be removed by scraping the inside of the tower. CAUTION: Be careful to avoid scratching the detector window.

E. Optics Cleaning

The presence of contamination on any of the optical components of the detector could reduce the transmission of light, and thus affect the detector sensitivity. Care should be exercised to avoid leaving contamination (e.g., fingerprints) on the detector window, lenses, optical filters, and PMT.

A slight accumulation of contaminants may occur on the inside of the window in the detector tower during normal operation of the FPD, therefore, the window should be checked occasionally and cleaned or replaced if not clear.

To remove the tower window for cleaning:
(1) Remove the detector from the GC as described in paragraph 2.4.4 A.

(2) Remove the four 4-40 x 1/4" screws holding the collar plate assembly (see Figure 2-3) to the hexagonal mounting bars, and separate the PMT housing section of the detector from the tower section.

(3) Remove the three 4-40 x 7/8" screws holding the window assembly to the tower. Be careful not to lose the spacers when removing the screws. Separate the component parts, collar adapter, collar plate assembly, O-ring, window, and Teflon gasket.

(4) Clean the window using acetone and a lint-free cloth.

While at this stage of disassembly, check the outside of the lens assembly and clean the surface with acetone if necessary. It is not normally necessary to disassemble the lens assembly.

To reinstall the tower window:
(1) Inspect the window, O-ring, and Teflon gasket. Replace any defective part. A spare window (P/N 28-000424-00) and a spare O-ring (P/N 27-402828-00) are supplied in the FPD startup kit (Kit No. 03-905949-00).

(2) Reassemble the window assembly in the sequence shown in Figure 2-3: Teflon washer, window, O-ring, collar plate assembly, and collar adapter. Be sure to orient the collar plate assembly and collar adapter correctly, as indicated by alignment of the screw holes.

(3) While holding these components in place, insert each of the three 4-40 x 7/8" mounting screws through the collar adapter, collar plate assembly and a spacer. Thread each screw into the detector tower. NOTE: The threads of the bottom screws must be wrapped with Teflon tape (P/N 49-000003-00) to seal the tower against gas leakage through the screw threads.

(4) Before reconnecting the PMT housing to the collar plate assembly, check the shield tube O-rings for deterioration or breakage. Replace if necessary (see paragraph 2.4.4 F).

(5) Place the shield tube over the O-ring on the lens assembly, then reinstall the four 4-40 x 1/4" screws holding the collar plate assembly to the hexagonal mounting bars.

(6) After tightening the four screws, slide the shield tube over the O-ring on the collar plate assembly. Push the tube toward the tower until it fits flush against the collar plate assembly.

(7) Reinstall the detector in the GC as described in paragraph 2.4.4 C.

F. O-Ring Life and Replacement
There are five O-rings used in the FPD assembly (see Figure 2-3). If the FPD is continuously or frequently operated at or near its maximum specified operating temperature (250°C), the O-rings associated with the detector tower may exhibit some deterioration over a period of time. However, performance of the detector will probably not be affected unless the detector is disassembled and reassembled without replacing the O-rings. The only seal that is likely to affect performance is the one between the FPD adapter plate and the detector tower. A gas leak at this point could affect the reproducibility of chromatograms by causing a change in the radio of gases supplied to the flames.

Any of the O-rings that are exposed to observation during disassembly for any reason should be inspected and replaced if deteriorated or broken. Spare O-rings for the adapter-to-tower seal and for the tower window seal are supplied in the FPD startup kit (P/N 03-905949-00). Additional O-rings may be ordered as the following Part Numbers:

Adapter-to-tower O-ring	P/N 27-402832-00
Tower window O-ring	P/N 27-402828-00
Exit tube plug O-ring	P/N 27-409195-00
Shield tube O-ring (narrow)	P/N 27-402827-00
Shield tube O-ring (wide)	P/N 27-402826-00

G. Photomultiplier Tube (PMT) Replacement

The PMT in the detector will normally function properly for a long period of time if not overheated and if not overexposed to light while voltage is applied. As the tube ages, its sensitivity may decrease slightly, therefore the gain of the tube should be periodically checked as described below (● PMT GAIN Adjustment) and readjusted if necessary.

If it has been determined that the PMT is defective, replace it as follows:

(1) Turn off the PMT high voltage supply be depressing the POWER OFF pushbutton switch on the FPD Controller module.

WARNING: Dangerous voltage is exposed when the PMT housing is opened. Be sure the high voltage is turned off before servicing the PMT.

(2) Remove the four corner screws in the top of the PMT housing and remove the top plate with its attached filter holder.

(3) Remove the defective PMT by pulling up on it while slightly rocking it back and forth.

(4) Align the base pins of the new PMT with the holes in the tube socket and insert the tube. Press the PMT firmly into the socket until it bottoms out on the socket.

(5) Make sure the side of the PMT toward the lens assembly is clean. If necessary, wipe it with a clean lint-free cloth moistened with acetone.

(6) Reinstall the housing top plate, making sure that its gasket is properly in place, and secure the plate with the four screws.

(7) After replacing the PMT, check the gain adjustment as described in the following procedure.

● **PMT GAIN Adjustment Procedure**

The GAIN adjustment on the front panel of the FPD Controller module adjusts the high voltage applied to the photomultiplier tube. For optimum dynamic range of the detector signal, as set at the factory, adjust the GAIN control as follows:

(1) Set up the instrument:
- 20" Test Column installed
- Phosphorus-mode filter installed
- Internal Time Constant switch set to .2 Sec
- GC Power On
- Detector flames lit
- Injector temperature set to 220°C
- Detector-oven temperature set to 220°C

(2) Set the FPD Controller front panel controls as follows and allow 30 minutes for the detector temperature to stabilize.

POWER	ON
OUTPUT	DIR (direct)
RANGE	10^{-10} A/mV
ATTENUATOR	256
ZERO	Fully counterclockwise

(3) Set the FPD controller ATTENUATOR switch to ∞ and zero the recorder baseline.

(4) Reset the ATTENUATOR switch to 256 and adjust the FPD Controller ZERO control to position the baseline level at 0% on the recorder.

(5) Inject 1.0 µl of FPD Test Sample in the appropriate injection port.

(6) Observe the recorder pen deflection. The chromatogram should have a small solvent peak, followed by a large tributylphosphate peak and a moderate-sized methylparathion peak. Check the tributylphosphate peak for a height of 70% ±5% (with He carrier gas).

(7) If the peak height is not as specified, note the position of the GAIN control on the front panel of the FPD Controller and adjust the control as required to obtain the correct peak height. Clockwise adjustment increases peak height; counterclockwise adjustment decreases peak height.

(8) Repeat Steps 5 through 7 until the peak height is correct.

(9) Set the ATTENUATOR switch to 4 and turn the ZERO control fully counterclockwise.

(10) Check the recorder trace for flame background and noise. The background level (offset from 0%) should be less than 70% and the noise should be less than 2%.

NOTE: After the operator has become familiar with his system and knows the typical background level of the detector, this level can be used for readjusting the GAIN control, without the need to inject any samples.

H. Ignitor Replacement

There are two types of FPD ignitors available, for operation with or without the 6000 GC flameout/reignite option. The standard ignitor is simply a resistance coil mounted above the second flame in the detector. The ignitor for use with the flameout/reignite option also has a thermocouple at each end of the coil for detecting the presence or absence of the flame and indicating that status to the Readout/Temperature Controller ESP panel. NOTE: Automated operation with the CDS 111C is inhibited when the FLAME light is on.

If the detector flame will not ignite automatically or by pushing the ignite button, check the ignitor coil as follows:

(1) Turn off the 6000 GC Power switch and turn off the hydrogen and air shutoff valves (carrier gas should be left on).

(2) Remove the GC snap-on detector cover.

(3) Allow the top of the detector and the exit tube to cool to handling temperature.

(4) Remove the two screws holding the top clamp on the FPD tower (see Figure 2-3) and remove the top clamp and the exit plug assembly.

(5) Turn on the GC power switch. (It is not necessary to turn on the FPD Controller for this check.)

WARNING: HIGH VOLTAGE The ignitor coil in the detector tower may be at approximately 270 Vdc with respect to chassis ground when the GC power is on.

(6) Press the GC front power panel IGNITOR switch to the appropriate position (A or B) for approximately 5 seconds while checking for ignitor coil glow through the hole in the top of the detector tower. If the coil glows red, the lack of flame ignition is due to some other cause such as incorrect gas flows.

If there is no ignitor coil glow, turn off the GC power switch and check the ignitor cable and cable connections before replacing the ignitor. Also, check continuity of the coil before removing the ignitor from the detector tower. Resistance between the two terminals of the ignitor connector should be very low (<3 ohms).

(7) If the ignitor is defective, replace it as follows:

(a) Carefully unscrew the ignitor from the detector tower.

(b) Wrap the threads of the new ignitor with Teflon tape (P/N 49-000003-00) being careful not to disturb the ignitor coil (or the thermocouple junctions on the flameout/reignite version).

(c) Screw the new ignitor into the tower. For the standard ignitor, screw it in until the flange on the connector stops against the tower wall. For the flameout/reignite version, screw the ignitor in until it is about one thread short of bottoming out, then continue slowly until the connector is oriented as shown in Figure 2-5. NOTE: For the flame monitor function to perform properly, the thermocouples must be oriented one above the other, with the correct thermocouple junction at the top.

(d) Check the ignitor operation as described in Steps 5 and 6.

(e) Turn off the GC and reinstall the exit plug assembly with the exit tube pointing toward the front of the GC. Secure the top clamp on the detector tower with the two 8032 x 1/4" screws.

(f) After installing a new ignitor, check the flame monitor threshold adjustment as described in the following procedure.

- **Flame Monitor Threshold Adjustment (Optional)**

In a 6000 GC equipped with an FPD and a flameout/reignite option, the flame monitor adjustment on the Flameout/Reignite PC Board should be checked whenever the flame-sensor ignitor is replaced or whenever the flameout/reignite circuitry appears to be malfunctioning.

Check the flameout/reignite function as follows (assuming that all gas flows have been adjusted properly).

NOTE: The following procedure is for a single flame-sensor ignitor in an FPD mounted in channel B of the GC (the normal channel for FPD operation). If the detector is installed in channel A, all references to "channel B" should be interpreted as "channel A".

(1) Remove the snap-on detector cover and the left top cabinet cover from the 6000 GC.

(2) Referring to Figure 2-5 make sure that the flame-sensor ignitor is properly aligned.

(3) Turn on the GC power and set the detector oven control for the normal detector operating temperature (e.g., 200°C).

(4) Set the Flame Monitor switch (see Figure 2-6) to the B position.

(5) Turn on the carrier gas and both air supplies to the detector, then ignite the detector flames by pressing the 6000 GC front power panel IGNITOR switch to the B position and turning on the hydrogen supply to the detector at the Air/H_2 block. Verify that the flames have ignited by holding a shiny metal object in the effluent stream from the detector exit tube or by observing the pen deflection on the recorder. If the red FLAME (NOT READY) light on the Readout/Temperature Controller ESP Panel does not go out within approximately 30 seconds, proceed to the adjustment procedure following Step 7.

(6) Allow about 30 minutes for the detector temperature to stabilize.

(7) Turn off the hydrogen supply at the Air/H_2 block, wait about 3 seconds for the flames to extinguish, then turn the hydrogen gas on again. Within about 30 seconds, the red FLAME light should come on indicating the flameout condition. The reignite circuit should then attempt to reignite the flames. A slight "pop" sound will occur when the flames ignite.

Within approximately 30 seconds, the FLAME light should go out. (For an instrument with the flameout option but not reignite, the FLAME light should come on within 30 seconds of the time that the hydrogen is turned off. Manually reignite the flames. The FLAME light should go out within 30 seconds.)

Adjust the flame monitor threshold control as follows if operation of the FLAME light or the reignite circuit is not correct:

(1) Turn off the hydrogen supply to the detector at the Air/H_2 block. Wait about one minute for the detector temperature to stabilize.

(2) If the FLAME light is already out, proceed to Step 3. If the FLAME light is now on, inset a recessed-tip plastic screwdriver through the channel B adjustment access hole in the protective screen (see Figure 2-6) and turn the potentiometer clockwise until the FLAME light goes out. For older instruments which do not have access holes in the protective cover, turn off the GC, remove the cover, and turn the power on again before making this adjustment.

WARNING: Dangerous voltage 270 Vdc may be present on the Flameout/Reignite PC Board. Use caution when servicing, and avoid use of a metal screwdriver.

(3) Turn the potentiometer slowly counterclockwise until the red FLAME light just comes on. Note the position of the screwdriver.

(4) Manually ignite the FPD flames by pressing the GC IGNITOR switch to the B position then turning on the hydrogen supply to the detector. Within about 30 seconds the FLAME light should go out.

(5) Turn the channel B threshold adjustment clockwise again, while counting the number of turns of the screwdriver, until the FLAME light just comes on. At this point, the reignite circuit will attempt to reignite the flames, but will not detect that the flames are already burning, due to the misadjusted potentiometer. Ignore this action and proceed quickly to Step 6.

(6) Turn the threshold potentiometer counterclockwise one-half the number of turns counted in Step 5. After one minute the system should stabilize and the FLAME light should go off.

(7) Check operation of the FLAME light and the reignite circuit as described in the Check procedure above.

(8) After completion of the check and/or adjustment procedure, be sure the Flame Monitor switch is set to the desired position (A+B or A). Reinstall the protective cover screen (if removed) and reinstall the top cabinet covers and detector cover.

2.4.5 Thermionic Specific Detector (TSD) Cleaning

A. Bead Cleaning

(1) Thermal—Increase Bead temperature. Heating the bead to a higher temperature will often boil off contaminating deposits.

(a) Increase hydrogen flow to about 7 ml/min.

(b) Increase the bead current until the bead glows bright orange. Allow a 30 second delay between setting the bead current and equilibration of the bead temperature.

(c) Hold the bead at this elevated temperature for about 30 minutes.

(2) Scraping—Non-volatile deposits can be removed by gently scraping the bead surface with a sharp tool or abrasive paper. The bead should be supported while being cleaned to prevent cracking the ceramic coating.

B. Collector Cleaning

Deposits forming on the collector may be removed with abrasive paper or by washing with water.

C. Flame Tip Cleaning

Deposits forming at the flame tip can be removed by scraping. Clean the flame tip bore with a fine wire.

D. Ferrule Replacement

Replace cracked or distorted flame tip ferrules with:

(1) Vespel for operating temperatures less than 350°C.

(2) Graphite (with metal backing ferrule) for applications above 350°C.

2.5 FILTER MAINTENANCE

The frequency of filter changes depends upon operating schedule and purity of supply gases. In average service large inlet filters are effective for up to three 300 ft^3 cylinders with impurity levels below 10 ppm.

See Table 2-1 and Figure 2-2 for specific data on location and maintenance.

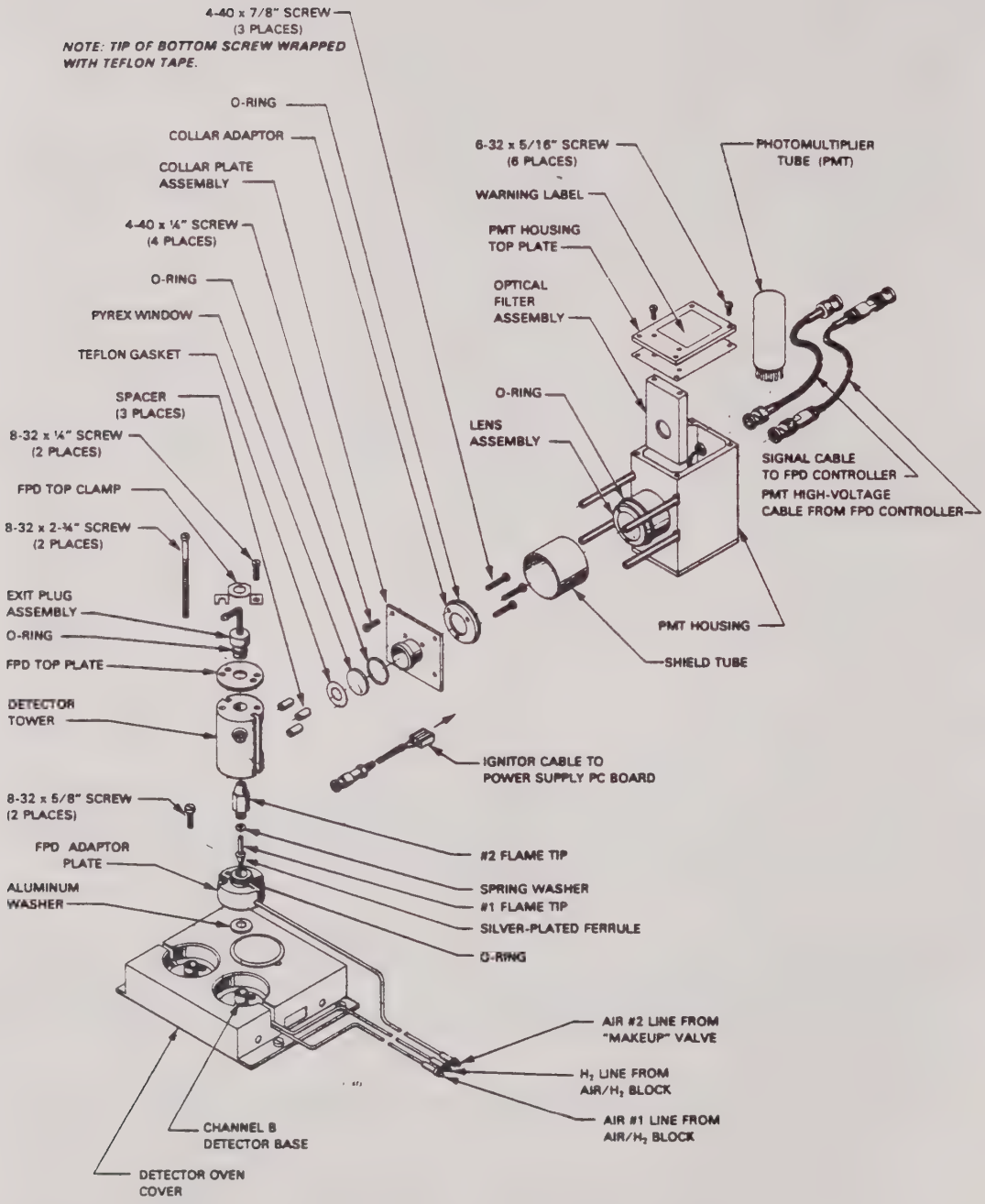


FIGURE 2-3 EXPLODED VIEW OF FPD

TABLE 2-1 STANDARD AND OPTIONAL FILTERS

Type Filter	Std/Optional	Purpose	Comments
Line Filter (P/N 68-000069-00)	Standard on all TCD and ECD instruments. Optional on all other instruments.	Protects from moisture and hydrocarbons when system is opened for septum or column change.	Change when detector signal indicates filters are no longer removing impurities.
Particulate Filter	Standard on all instruments.	Protects all instrument gas flow systems from particulate matter.	Change when higher supply pressures are necessary to achieve normal flow rates.
Inlet Filter (P/N 68-000070-00)	Optional on all instruments. Recommended for TCD and ECD.	Protects against hydrocarbon and moisture contamination from the supply cylinder.	Capacity approx. three 300 ft^3 cylinders of gas-impurity levels up to 10 ppm.
Oxygen Trap Filter (P/N 68-000056-00)	Optional on all instruments. Recommended for ECD.	Reduces oxygen and water in inert carrier gases.	Capacity approx. three 300 ft^3 cylinders.

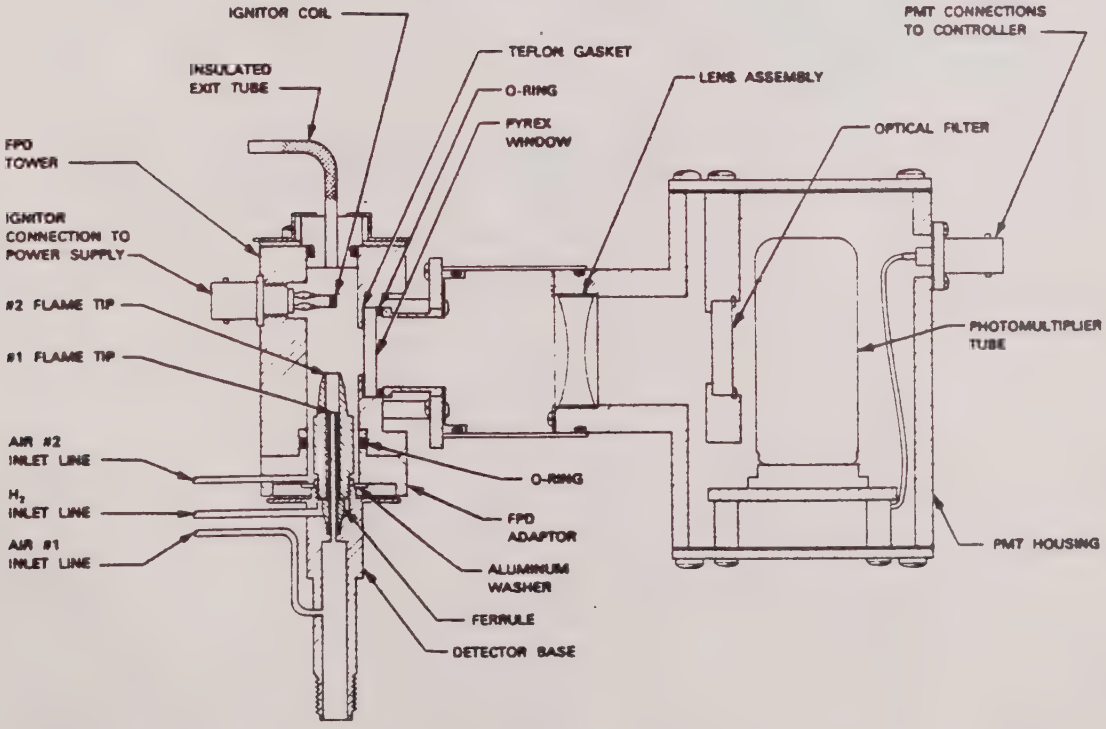


FIGURE 2-4 CROSS SECTIONAL VIEW OF FPD

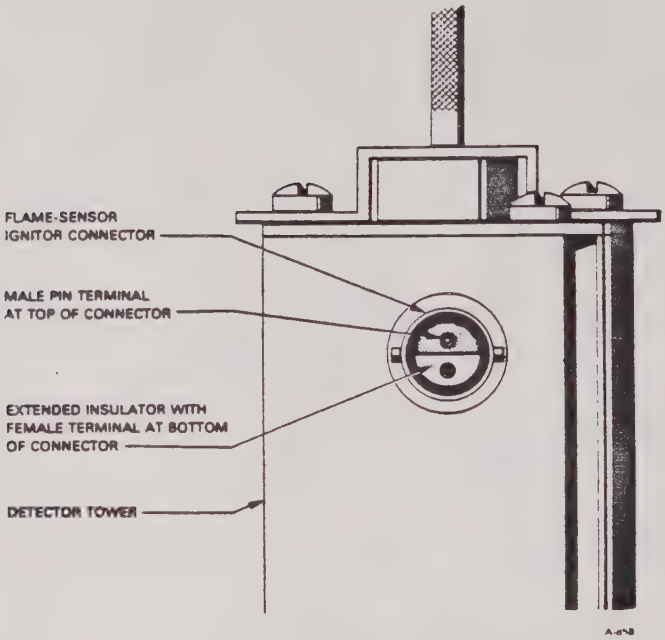


FIGURE 2-5 ORIENTATION OF FLAME-SENSOR IGNITOR (OPTIONAL) IN DETECTOR TOWER

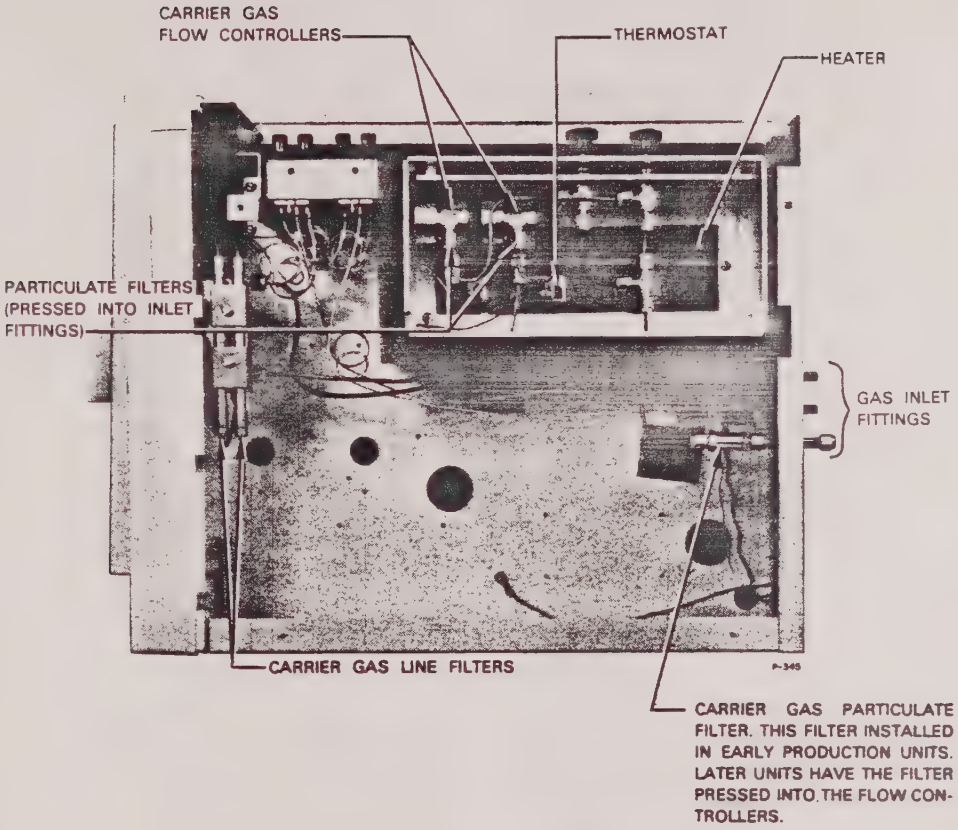


FIGURE 2-6 FILTER LOCATIONS PNEUMATICS CABINET

SECTION 3
CHROMATOGRAPHIC TROUBLESHOOTING AND SERVICE

3.1 GENERAL

The troubleshooting procedures outlined in this section are structured to accommodate two separate problem solving approaches. The two will be referred to as *case 1* and *case 2*.

In case 1, peak shapes, peak areas, elution times, baseline characteristics, etc. deviate from ***known*** responses of a familiar calibration sample. In this case the general characteristics of the chromatogram are well known and even slight deviations can be discerned.

In case 2 the problem solving is not as clear-cut since this involves the analysis of a sample with chromatographic characteristics unknown. In this instance, peak and baseline characteristics are ***obviously*** non-typical but a definite cause for the deviation, and the extent of it must be determined through more comprehensive evaluation.

3.2 CASE 1

Deviations from normal performance are easily detected since an acceptable chromatogram is well documented.

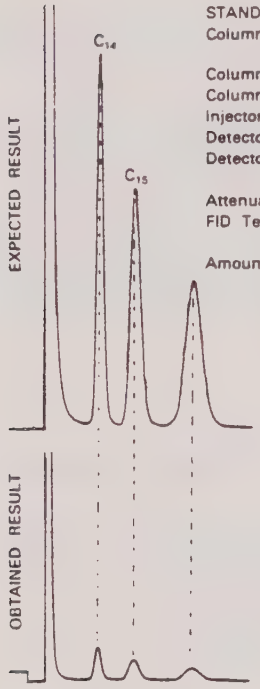
A vast majority of gas chromatographic malfunctions will be indicated by one or more of the following symptoms; inspect the chromatogram for ***all*** of the symptoms:

- Change in peak size (peaks of different area, or height than expected)
- Change in retention times
- Change in baseline stability
- Unsymmetrical peak shapes (skewed, non-Gaussian etc.)
- Change from expected peaks

3.2.1 Change in Sensitivity (Peak Size) With No Other Deviations

Definition: "Sensitivity" refers to peak size (height or area) for a certain amount of sample injected.

Description and/or Conditions: Peak area (or height) significantly different from the expected area (or height) of a calibration sample.



STANDARD 3700 TEST CONDITIONS:
Column: 1/8" x 20', 5% OV-101
H.P. Chrom G 100/120
Column Temp: 140°C
Column Flow: 30 ml/min N_2
Injector Temp: 250°C
Detector Temp: 250°C
Detector Flows: 30 ml/min H_2
300 ml/min Air
Attenuation, Range: 8 x 10^{-10} A/mV
FID Test Sample: 300 ppm
C_{14}, C_{15}, C_{16} in iso-C_8
Amount Injected: 1 µl

Example #1
Since the retention times are constant the change in sensitivity could not be due to a change in column temperature or column flow rate. Therefore a steady leak at the septum or the injector/column fitting is ruled out.

Most likely causes are associated with either the sample not being delivered to the detector or a sub par performing detector:

1. leak in the syringe
2. leak in septum during injection
3. plugged syringe
4. leak at column exit
5. contaminated detector

Preliminary checks:

☐ Check attenuation setting (avoid two attenuators in series)

☐ Check range selection

☐ Check mode selection for correct channel

☐ Check position of the input signal cable at rear of instrument:
1 mV for direct connection to recorder
1V for input to data system or integrator
10V for input to computer

☐ Check recorder span (1 mV full scale)

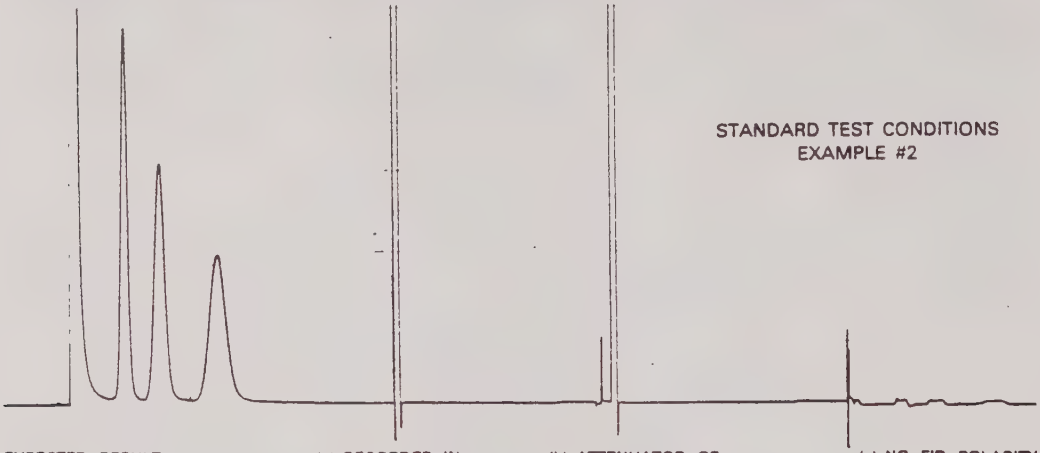
A. Changes in Sensitivity Due to Precolumn Causes

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Change in sample concentration due to solvent evaporation (Peak too large)	Use a fresh calibration standard. (Particularly important with the External Standard method of calculation; not so critical with Internal Standard.)
Sample Decomposition (Peak too small)	See above, avoid exposure to air, light, heat.
Partial plugging in syringe	Check sample in syringe barrel (bubbles). Eject sample and note volume or behavior of ejected liquid.
Leaky syringe	For 10 μl syringe. Holding plunger fixed with sample in barrel insert needle in injector. Injector pressure will force liquid past a faulty plunger/barrel fit.
Leaky Septum	Indicated by a decrease in head pressure at the moment of injection. Change septum Often but not always accompanied by an increase in R.T.'s also.
Column inlet leak	Indicated by decreased head pressure. Probably accompanied by an increase in R.T.'s also. Check column to injector fittings with Snoop® (sparingly). Refer to leak check procedure in appendix. Tighten leaking fittings ***only***. Install new ferrules if necessary.
Leak at column switching valve	Check fittings with Snoop, replace ferrules, tighten fittings.

B. Changes in Sensitivity Due to Post Column Causes

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Leak at column switching valve	Leak check with Snoop®. Tighten fittings, replace ferrules.
Column to detector leak at fitting (column outlet)	Tighten fittings—Check with Snoop. Check glass column for chipped end.
Flame Jet (Contamination or clogging)	Remove, inspect, clear bore with fine wire. Scrape off accumulations of SiO_2 or carbon deposits
Low or no flame jet polarization voltage	Remove collector electrode and ceramics—Measure the flame tip potential with ***high impedance*** voltmeter—should read ±250 Vdc. Check high voltage Power Supply PC Board
Flame support gases not set to manufacturer's suggested flow rates	Measure and reset flows
Make-up gas off or too low	Measure and reset to recommended flow (Particularly important in capillary work)
Electrometer sensitivity inadvertently shifted.	Check attenuator. Be sure attenuator knob is secure and correctly indexed on shaft.

C. Changes in Sensitivity so Great That Few if Any Peaks Remain



SOLVENT PEAK ONLY

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Incorrect channel selected	Check signal lead continuity from detector to electrometer
Recorder mode in standby (Example #2a)	Check knob position
Data system attenuator on infinity (Example #2b)	Check switch position
Gross leak at column fitting	Check for leaks*
Flame out from solvent overload	Check background current or H_2O condensation at detector exit.

*Refer to leak check procedure in appendix C.

NO PEAKS AT ALL

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Flame out on FID	Check condensation with mirror
No filament current with TCD	Check readout module for mA level
Signal lead disconnected	Check continuity of signal lead
Mode switch off	Check mode selection
No FID polarization voltage (Example #2c)	Check voltage at flame tip*

*Procedure reference in appendix D.

D. Changes in Sensitivity Due to Detector Contamination (FID)

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Combustion of organic silicones	White SiO_2 powder deposits on interior, detector surfaces should be cleaned off
Incomplete combustion of organic solvents particularly aromatics, chlorinated	Black soot deposits, other deposits can cause signal loss due to conductive path to ground; remove or replace ceramic insulators
Particulate matter inside flame jet	Remove jet, ream clean with wire

E. Change in Sensitivity With Tailing Peaks

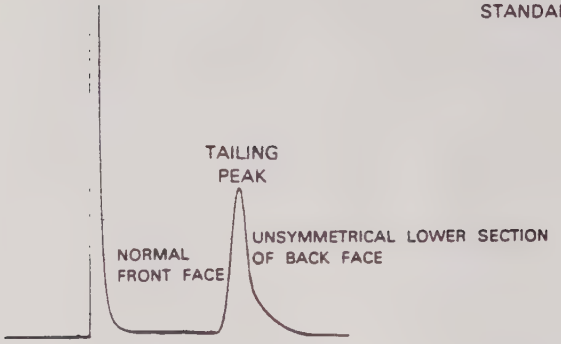
This peak has a normal leading slope and a partial normal back slope, but before reaching baseline, begins to lag (see 3-6 example #3).

This is the most frequently encountered deviation from a true Gaussian peak and can be caused by:

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Irreversible interaction of sample components with materials of the column: Column tubing Column packing Column liquid phase	 Derivatize sample Use glass tubing instead of metal. Use deactivated, silanized support* Change liquid phases*
Column contamination or stripping of partition liquid at injector end	Possibly due to excessive injector temp., solvent stripping, or an H_2O in carrier. Replace first few inches of column packing; use removable glass injector tube packed with silanized glass wool or column packing. Correct cause of contamination or stripping.
Thermally labile samples	Reduce column and injector temperature. Form derivative of the sample.
Injector port not hot enough	Increase injector temperature.
Using a gas sample valve	Leak-check valve. Increase GSV temperature.
Poor injection technique, size, speed	Inject smaller amounts (1-2 μl for on-column) Increase speed of injection
Column not installed completely into injector fitting	Check depth of column penetration into the injector, remove ferrule and replace at full depth.

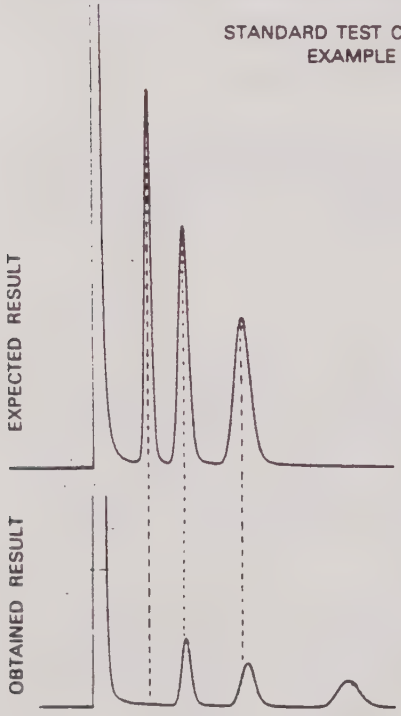
*Column deactivation sometimes is successful with several 10 μl injections of BSA derivatizing agent (for silicone columns) OR by priming the column with several injections of a concentrated solution of the substance at concentrations 100-1000 times greater than being analyzed.

STANDARD TEST CONDITIONS
EXAMPLE #3



3.2.2 Change in Sensitivity With Change in Retention Time

STANDARD TEST CONDITIONS
EXAMPLE #4



Example #4
A change in retention time can only be caused by a change in column temperature or flow rate. Although a temperature change will cause a change in peak height the area will remain constant.

NOTE: Check for a change in the "Air Time" or solvent front time: a change in temperature will have no effect on these retention times; a flow change will effect these times in the same proportion as peaks of interest.

A. Changes in Sensitivity Due to Flow Change

1. Leak at the Septum
2. Leak at the column fitting
3. Flow controller problem
4. Carrier supply problem

Concentration Type Detector TCD or ECD

If the column flow decreases the retention times increase resulting in peak heights that will probably be increased, but could be smaller, or the same as before, but the areas will be larger.

Mass Flow Type Detector FID, FPD, or TSD

A decrease in column flow rate causes increase in retention times which yield smaller peak heights but little change in peak areas.

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Flow controller set point was changed	Check column head pressure reading, remeasure column flow rate, reset.
Flow controller not controlling flow due to internal malfunctions	Same as above, except replacement may be necessary.
Flow controller not controlling flow due to variation in supply pressure.	Check column head pressure reading, check cylinder pressure reading, replace carrier gas supply when cylinder pressure drops below 500 psig.

B. Changes in Sensitivity Due to Changes in Column Temperature

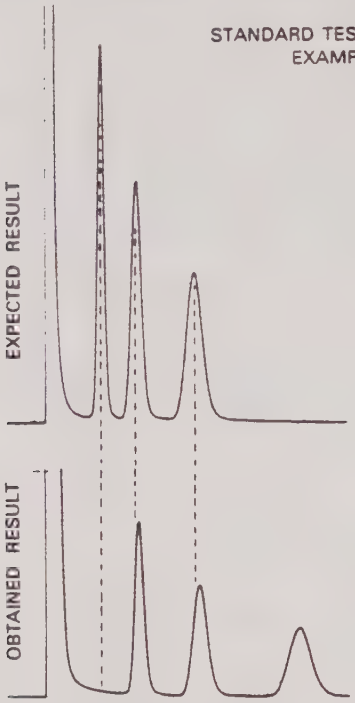
1. Assuming no problem with the carrier flow rate.

2. A lower column temperature will increase retention times, decrease peak height but the area will remain constant (not a true senstivity decrease).

3. A higher column temperature will decrease retention times, increase peak height but area should remain constant if ***linear range of detector is not exceeded.***

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Set point on column oven changed	Verify at readout module
Malfunction of ALTP	Monitor column temperature during run, check closure of column oven door
Inconsistent initial temperature when programming	Insufficient equilibration time after cooldown

3.2.3 Changes in Retention Time



EXAMPLE #5
Changes in retention time can only be caused by changes in flow rate or column temperature. Retention time changes accompanied by sensitivity changes have been discussed in Section 3.2.1. Since changes in retention time cannot be caused by the detector, the most likely source of the problem is associated with the column and its temperature and its flow rate.

A. Change in Retention Time Due to Variation in Carrier Gas Flow Rate

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Septum leak	Compare column head pressure, check with Snoop, replace periodically with reconditioned septum. This may also cause a change in sensitivity
Column leak at injector fitting	Compare column head pressure to previous value, check with high pressure leak check or Snoop, tighten or replace ferrule
Flow controller instability	Check regulator pressure at cylinder. If tank pressure is below 500 psig, replace cylinder

B. Changes in Retention Time Due to Column Oven Temperature Change

Reproducible retention times are directly dependent upon reproducible isothermal or programmed temperature profiles. Verify consistency of column oven temperature.

C. Changes in Retention Time Due to Change in Column Packing

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Loss in liquid phase	Check recommended upper temperature limit (extended exposure at elevated temperature will deplete the liquid phase and hence shorten retention times); replace column
Sample interaction with column	Check peak symmetry which may also be changed, e.g., tailing (natural product extracts will commonly have impurities that accumulate in the column and react with subsequent sample injections)
Column overloaded with sample	Check the component load injected into the column e.g., more than about 10 μg will start to overload a packed column with a 3% coating of liquid phase. Check the peak symmetry, for overload see 3.3 D and E. Overloaded packed column will yield longer retention times; overloaded adsorption columns will yield shorter retention times

D. Changes in Retention Time Due to Variation in Injection Technique

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
All of the sample not starting thru the column at the same time	Check the recommended injection technique*; excessively slow injection speed will cause the peak shapes to be distorted

*Procedures reference is appendix B.

NOTE: An irregular strip chart recorder drive will exhibit an apparent variation in peak retention times. Check consistency of chart drive speed in all ranges against an accurate clock or timer. Use a stopwatch to check repeatability of chart speed between major graduations of the chart paper.

3.2.4 Changes in Baseline Stability

Definition: Baseline is the signal behavior with no sample present. Baseline instabilities can be a symptom of both mechanical and/or electrical defects. Following are graphic examples of commonly encountered baseline anomalies and associated causes.

A. Increased Noise Level (With Negligible Drift)

STANDARD TEST CONDITIONS
EXAMPLE #6

(a) EXPECTED RESULT (1×10^{-12})

(b)

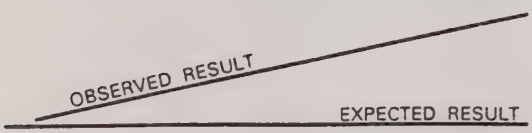
OBSERVED RESULT

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Ground loop	Check AC power socket for "earth" ground for GC, data system and recorder; check that signal shields are grounded per the appropriate manuals.
Detector contamination	Check for unusual drafts over detector compartment, check ambient air purity for unusual pollutant levels, check FID detector insulators for contaminants and use necessary procedures* as needed; bake-out TCD at 300°C with clean He only flowing (filament current off or at least decreased).
Recorder slide wire contaminated	Check baseline with signal disconnected at the detector. Clean slide wire as outlined in recorder manual.

*See reference in appendix E.

B. Unidirectional Drift (Upscale or Downscale) With Indefinite Duration

STANDARD TEST CONDITIONS
EXAMPLE #7



Possible Causes	Things to Check, Change, Clean, Compare or Correct
Continuous oxidation of TCD filaments	Perform pressure leak check, TCD cell may need to be replaced (O_2 back diffusion at any fitting could be responsible)
Detector, system decontamination after start up particularly with new or under conditioned column	Overnight bakeout procedure* at the recommended upper conditioning temperatures for the column.
Detector contamination or decontamination particularly ECD	Check purity of carrier gas. Try open tube from injector to detector. Condition overnight at elevated temperature
TCD flows not balanced	Check flow rates of both channels

*See procedure in appendix E.

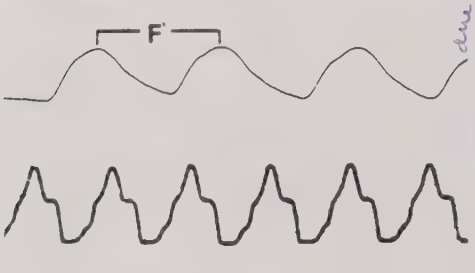
C. Erratic Drift

STANDARD TEST CONDITIONS
EXAMPLE #8

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Column operated at excessive temperatures	Check the operational temperatures for liquid phases.*
Amplifier range too sensitive	10^{-12}A/mV for FID and .05 mV/mV for TCD should be reserved for only the exacting detectivity problems. Highest sensitivity setting may not be usable with the particular column and temperature.
High boiling sample impurities gradually eluting from column	Check bakeout procedure* and recondition column.

*See procedure in appendix E.

D. Cycling



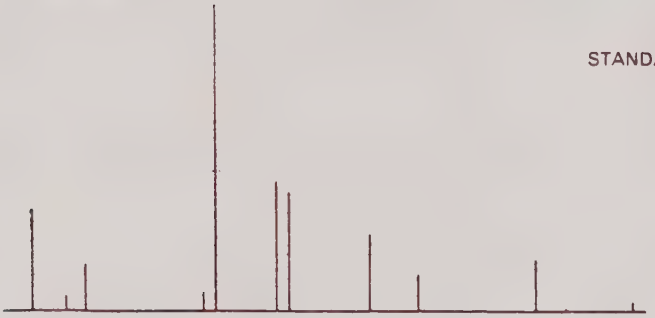
STANDARD TEST CONDITIONS
EXAMPLE #9

STANDARD TEST CONDITIONS
EXAMPLE #10

STANDARD TEST CONDITIONS
EXAMPLE #11

Possible Cause	Things to Check, Change, Clean, Compare or Correct
Thermal problem, example 9	Check temperature stability of injector, column, and detector with readout module and/or systematically change the set point by 10°C of each of the controllers in sequence. The pattern will change within one F period (see example 9) after the associated controller is changed.
Pneumatic problem in pressure regulator, example 10	Change the set point pressure of the pressure regulator to a higher pressure (+5 psig); if cycling is interrupted, then resumes after ~30 sec, the regulator is not controlling at this pressure. Try increasing pressure, replacing regulator
Pneumatic problem in flow controller, example 11	Replace flow controller.

E. Spikes



STANDARD TEST CONDITIONS
EXAMPLE #12

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Detector contamination	Check decontamination procedures for FID flame jet. Some spiking is common when the flame has been off for over a day. Air borne particulates are most frequently the cause therefore protecting the exit orifice from atmospheric particles falling into the detector is important
Recorder slide wire (spikes at the same position on the chart,	Follow recommended procedure for cleaning of slide wire.
Electrical interference from external sources	Check for heavy current drains on the same power circuit as the chromatograph. Isolation transformer may be needed.

3.2.5 Unsymmetrical Peak Shapes

Peaks deviating markedly from a true Gaussian shape will often indicate, by the nature of the deviation, either a procedural error or a system defect. A Gaussian peak is symmetrical in shape with the leading slope very similar to the back slope.

A. Tailing Peaks

Since this symptom has been covered in detail in a previous discussion please refer to 3.2.1 E.

B. Negative Peaks

STANDARD TEST CONDITIONS
EXAMPLE #13

Possible Causes	Things to Check, Change, Clean, Compare or Correct
Electrical All peaks reserved	Reverse output signal.
Contamination in Carrier Gas (Some peaks reserved in direction of response)	Reverse output signal. Vacancy chromatography. Particularly in trace analysis, concentration of certain component is greater in the carrier gas (impurity) than it is in the sample. Condition is common with TCD when leak into carrier gas. Contaminated septa controller diaphrams, depleted gas filters, etc. can contribute to this condition. Successful trace analysis demands that the system be at optimum performance: (1) Reduce all electrical interference to a minimum by shielding and using isolated regulated power circuits. (2) Be sure all gas inlet filters are functional so that highest purity is assured. (3) Use cylinder gases of proven purity. (4) System may need to be leak checked.
Contamination in detector	Decontaminate or replace insulators in FID. Decontaminate ECD foil.
Partial negative response	"W" shaped peaks – when using TCD to analyze for H_2: with H_2 concentration above 3%, negative H_2 peak results; with H_2 concentration below 3%, positive H_2 peak results. Phenomenon can be minimized by either changing the sample loop size or using 8% H_2, 92% He carrier gas which always yields negative H_2 peaks.

C. Peak Stepping

Check recorder gain. Increase recorder gain control.

STANDARD TEST CONDITIONS
EXAMPLE #14

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Electrical dead band	Check by means of a momentary, manual offset at the recorder pen: pen should quickly return to start position. Increase gain and/or decrease damping.
Mechanical dead band	Lubricate recorder pen slide bar, pulley system, etc. Refer to recorder manual.

D. Square Topped Peak

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
a) recorder stop has been reached	An offscale solvent peak will result in this shape - not a defect.
b) Electronic or Detector saturation due to sample overload	Select less sensitive range setting. The best range setting is the most sensitive position that will hold all peaks of interest on scale at an attenuation of 1024X with a 1 mV recorder. Reduce sample volume or concentration.

E. Round Topped Peak

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Detector overload ECD, TCD, FID	Reduce sample volume, concentration.

3.2.6 Unexpected Peaks

Peaks that cannot be accounted for on the basis of the known composition of the injected sample. Such peaks are often out of order in peak width as shown in the example below:

STANDARD TEST CONDITIONS
EXAMPLE #15

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
a) High boiling sample components eluting from previous injection	Perform rapid temperature program after each analysis to purge high boiling impurities out of column.
b) Ghost peaks from septum, unconditioned column, contaminated carrier gas, previous sample components	To confirm ghost peaks from septum or contamination upstream from column: (1) Measure cool down and reequilibration time. (2) Run temp. prog. and measure the magnitude of ghost peak. (3) Allow twice the cool down and equilibration time. (4) Repeat program and peak measurement. If peaks are doubled, this confirms upstream contamination. To isolate contamination from other upstream causes install the Teflon injector blank-off plug and repeat above procedure. If ghost peaks disappear the septum is at fault and can be minimized by: (a) better quality septum (b) lower injector temp. (c) preconditioning of septum (d) short as possible initial hold before programming If ghost peaks persist upstream contamination is indicated and can be minimized by installing a 1/8" x 6" long molecular sieve trap between the flow controller and the injector

3.3 CASE 2

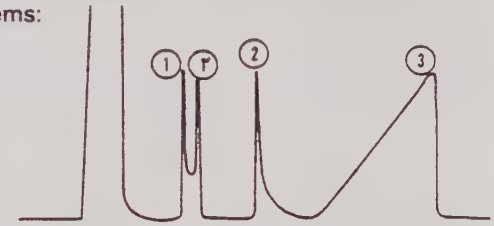
This is the infrequent situation where the analyst knows the components to be separated but has no prior chromatographic history to make a comparison. Careful interpretation will be required in concluding the base course of action. Even then the "cut and try" approach will probably play a large role in finding an acceptable separation.

When starting from this position it is frequently advantageous to consult the literature or authorities in the field. When this is not possible chromatographing the individual components is the next recommended procedure. The hypothetical composite chromatogram below illustrates the three most common separation problems:

(1) Insufficient resolution,

(2) Tailing peak,

(3) Leading peak.



A. No Peaks

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Reference back to CASE 1 section 3.2.1 C	
Column temperature too low	Find retention time of an easy component, such as an alkane, as a boiling point reference to compare to boiling of peak of interest.
Column too long	Be more patient for peaks to elute or temperature program the column.
Liquid phase loading too high	Measure background current if previous reference is available: a factor of 2 or more larger background current could mean the column needs to be reconditioned or replaced.

B. Insufficient Resolution (Between Peaks 1 and 1')

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Temperature of the column too high	Repeat the analysis with a lower column temperature by about 25°C. Depending on the relationship to the other peaks a temperature program might be advantageous.
Non optimum column flows	The column flow rate usually will cause only small differences in resolution unless a very low flow is used. Suggested flows for best resolution are shown below:
Column too short	Although the number of plates increases linearly with an increase in column length (providing the packing efficiency can be maintained) the resolution only increases by the square root of the increase in column length i.e., a 4 times longer column will only increase resolution by 2 fold. Another consideration to increasing column length is the resulting increase in column inlet pressure. Above about 40 psig leak problems start to be a limiting factor. Usually a 1 to 3 meter, 2 mm i.d. packed column is recommended for maximum column length.
Poor choice of column liquid phase	Selecting a liquid phase of different polarity may help if there is a difference in polarity of the components.

Column Internal Diameter

	2 mm	4 mm
N_2	12-15 ml/min	25-30 ml/min
He	35-40 ml/min	60-65 ml/min

NOTE: In practice column flows are usually about double these values in the interest of shorter analysis time.

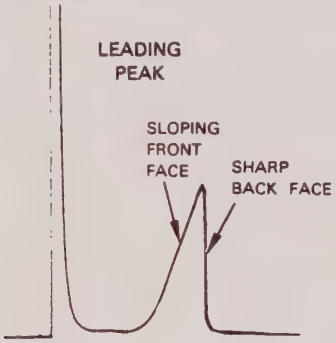
Possible Causes	Things to Check, Change, Clean, Compare, or Correct

	If (1) is more polar than (1')
	• a lower polarity liquid phase will improve the separation.
	• a slightly higher polarity liquid phase will reduce separation or cause co-elution.
	• a much higher polarity liquid phase may provide separation with (1') eluting before (1)
	If (1) is less polar than (1')
	• a lower polarity liquid phase will reduce separation or might yield a separation with (1') eluting before (1)
	• a more polar liquid phase will yield more separation

C. Unsymmetrical Peaks, 2

Reference the section in Case 1 under 3.2.5.

D. Leading Peaks — Those Peaks Exhibiting a Slow Rise to Apex With a Sharp Drop to Baseline 3



EXAMPLE #16

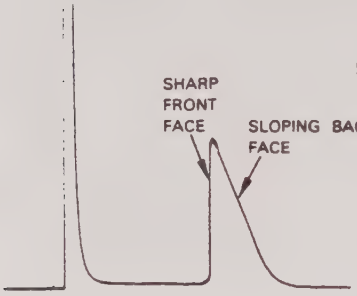
CONDITIONS: Partition column operating at a temperature below the boiling point of the compound (the usual case).

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Column overload due to an excessive amount	Inject a smaller volume of sample or dilute the sample mixture.
Column overload due to insufficient column temp.	Increase the column temperature.
Column overload due to insufficient liquid phase on the solid support e.g., possibly from extended operation at excessive temp., or O_2 in carrier gas, H_2O in carrier gas	Replace the column with a new one. Change column composition to a higher % liquid phase coating (about 20% is maximum possible loading for the Chrom W's, 10% for Chrom G, and 40% for Chrom P).
Carrier velocity too low	Increase column flow rate.

E. Reverse Leading Peaks

Those peaks exhibiting a sharp rise to Apex followed by a slow constant return to baseline.

Conditions: Adsorption column operating at a temperature above the boiling point of the solute component.



EXAMPLE #17

CONDITIONS: Adsprption column operating at a temperature above the boiling point of the compound (the usual case) OR partition column operating at a temperature above the boiling point at the compound such as a solvent (the usual case).

Possible Causes	Things to Check, Change, Clean, Compare, or Correct
Column overload due to an excessive amount of sample	Reduce the volume of sample injected.
Column temperature too high	Reduce column temperature.
Carrier velosity too low	Increase flow rate.

SECTION 4

VISTA G.C. ELECTRICAL AND ELECTRONIC TROUBLESHOOTING

SECTIONS

1) Introduction

2) Abbreviations Used In This Text

3) Vista Series Definitions

4) Tools and Equipment Required

5) Instrument Access

6) Layout of the VISTA G.C. Chromatograph

7) Electrical Power and Fuses

8) Test Points, Voltages Checks, Adjustments and Calibrations

9) Circuit Board Descriptions

10) Defining and Troubleshooting Problems

11) Appendix

SECTION 4

ELECTRICAL AND ELECTRONIC TROUBLESHOOTING AND SERVICE

1. INTRODUCTION:

The electrical/electronic service section provides instructions for associating an observed malfunction with the probable location of the cause. In general, the operator is directed through a series of diagnostic steps beginning with the most basic causes i.e., lack of power, power cord connections etc, then to fuse failures, and finally to an isolated Printed Circuit Board (PCB).

Correction of the malfunction is limited to PCB exchange only. These instructions do not advocate or encourage removal and replacement of electronic components. Pictorial component layouts will be included as illustrations. For those who desire further schematic drawings, these drawings are included in the VISTA Series Operators Manual. If additional copies of the Operators Manual are required, they are available from the Varian Service Center in Sunnyvale, California. The Varian Part No. is 03-913855-00.

2. ABBREVIATIONS and TERMS USED:

AC	= Alternating Current
A/D	= Analog to Digital
ADC	= Analog to Digital Converter
COLD START	= Power up to Preset Prameters
CPU	= Central Processing Unit
CRT	= Cathode Ray tube
D.A.	= Digital to Analog
DAC	= Digital to Analog Converter
DC	= Direct Current
DVM	= Digital Volt Meter
IC	= Integrated Circuit
LED	= Light Emitting Diode
PC	= Printed Circuit
PCB	= Printed Circuit Board
P/N	= Part Number
Pot	= Potentiometer(Variable Resistor)
PROM	= Programmable Read Only Memory
RAM	= Random Access Memory
ROM	= Read Only Memory
S.B.	= Slow Blow (Fuse)
S.S.R.	= Solid State Relay
TP	= Test Point
VAC	= Volts Alternating Current
VDC	= Volts Direct Current
VOM	= Volt Ohm Meter
WARM START	= Power up to Operating Parameters

3. VISTA G.C. DIFINITIONS:

3.1 4600 - A modular-based instrument that is Method controlled. A Method contains the information necessary to control an instrument during a chromatographic run. The Method is built in the VISTA 401/402 and transferred to the 4600 prior to the run. This instrument does not have a keyboard or a CRT display and cannot operate without connection to a VISTA 401/402.

3.2 4600B - A later model 4600 using VISTA 6000 software. This instrument operates in the same manner as the 4600. This instrument also does not have a keyboard or a CRT display and cannot operate without connection to a VISTA 401/402

3.3 6000 - A dual microprocessor Method-controlled Modular-based instrument that can store up to eight Methods with one Method always in control. Operating parameters are set using a keyboard and are monitored on a CRT screen.

3.4 6500 - A satellite GC with no control electronics. A VISTA 4600 or 6000 G.C. equipped with a Parallel/Serial interface PCB is required for operation

3.5 VISTA 64-A GAS CHROMATOGRAPHY SYSTEM consisting of a VISTA 6000 and VISTA 401/402.

NOTE: Many G.C.'s have been purchased as one model and upgraded to another model. The identification label that contains the model number and serial number will reflect the instrument configuration as originally ordered from the factory. This identification label is located on the upper left corner of the column oven as you open the oven door.

4. TOOLS AND EQUIPMENT REQUIRED:

4.1 The following tools and equipment are required for the repair and calibration procedures described in this section:

- Volt/ohm meter or 3 digit, digital voltmeter (preferred)
- Screwdriver flat blade (common) 4"x 3/16"
- Screwdriver Phillips 4" No. 2 Tip
- Screwdriver Phillips 4" No. 1 Tip
- Screwdriver flat blade 8"x 3/16 or Phillips 8" No. 1 tip (determined by which type of screw head is used to secure CRT module to instrument frame).
- Insulated adjustment tool (supplied with course)
- Insulated needle nose pliers
- Capillary "pick" (supplied with course)

4.2 The following tools are necessary for non-electrical system components:

- (2) each 1/4"x 5/16" open end wrenches
- (1) each 3/8"x 7/16" open end wrench
- (1) each 7/16"x 1/2" open end wrench
- (1) each 1/2"x 9/16" open end wrench
- (1) set of Allen wrenches (Hex)

5. ACCESS TO INSTRUMENT:

WARNING: While removing covers or protective panels, turn power switch off and unplug power cord. Some tests and calibrations are performed with power on. When protective covers are removed and power is applied to the instrument, high voltages are exposed and extreme caution should be observed.

5.1: REMOVAL OF LEFT SIDE ELECTRONICS MODULE COVER -

a. Remove screw at top right-hand side of electronics compartment.

b. Remove the blank panel (two screws at lower section of the electronics compartment).

c. Remove the screw at the lower left-hand side of the electronics compartment (this screw was covered by the panel removed in Step b.)

d. Push the electronics compartment cover toward the rear of the instrument and lift the cover off (the cover should move toward the rear of the instrument about 1/2" before it can be lifted).

5.2: REMOVAL OF UPPER ELECTRONICS MODULE COVER -

a. Open the hinged upper electronics cover so that the spring clip lock holds it open.

b. Remove the cover by loosening the three 5/16" nuts at the base of the cover.

5.3: REMOVAL OF THE REAR COVERS -

a. Remove the five Phillips screws that hold the rear cover in place, then slide the cover straight back off of the instrument.

b. Remove the four Phillips screws that hold the lower rear cover in place, then pull the cover down and away from the instrument and let it hang by its wires.

6. LAYOUT OF THE VISTA G.C. CHROMATOGRAPH:

6.1 GENERAL INSTRUMENT LAYOUT Figure 6-1

a. LOWER ELECTRONICS COMPARTMENT -

1. Not installed in the 6500 VISTA SERIES G.C.

2. Contains the lower Mother Board which holds the main operating Printed Circuit Boards, and the Battery/CRT (Display) module.

3. Contains the injector controller if the G.C. is equipped with the optional 1095/96 Programmable On-Column Injector

b. REAR ELECTRONICS COMPARTMENT -

1. Contains the main transformer, the TSD transformer (if G.C. is equipped with a TSD detector), wiring harness, and fuse blocks.

2. The oven fan and instrument cooling fan motor is located at the center of the rear electronics compartment

3. The Switched accessory outlets (115 VAC, 300 Watts total) are located on the lower back cover.

4. The automatic oven door motor and cam are located on the left side of the compartment.

c. UPPER ELECTRONICS COMPARTMENT -

1. Contains the Upper Mother Board which holds other operating and detector PCB's.

d. KEYBOARD PANEL -

1. Hinge mounted at left front of VISTA 6000 (Not part of the 4600 or 4600B).

E. CRT DISPLAY -

1. Mounted at upper left front of VISTA 6000 (Not part of the 4600 or 4600B).

6.2 LOWER ELECTRONICS COMPARTMENT LAYOUT -

a. LOWER MOTHER P.C. BOARD -

1. Mounted horizontally extending from front to rear of lower electronics compartment.

2. Contains only connectors and printed solder traces (no electronic components).

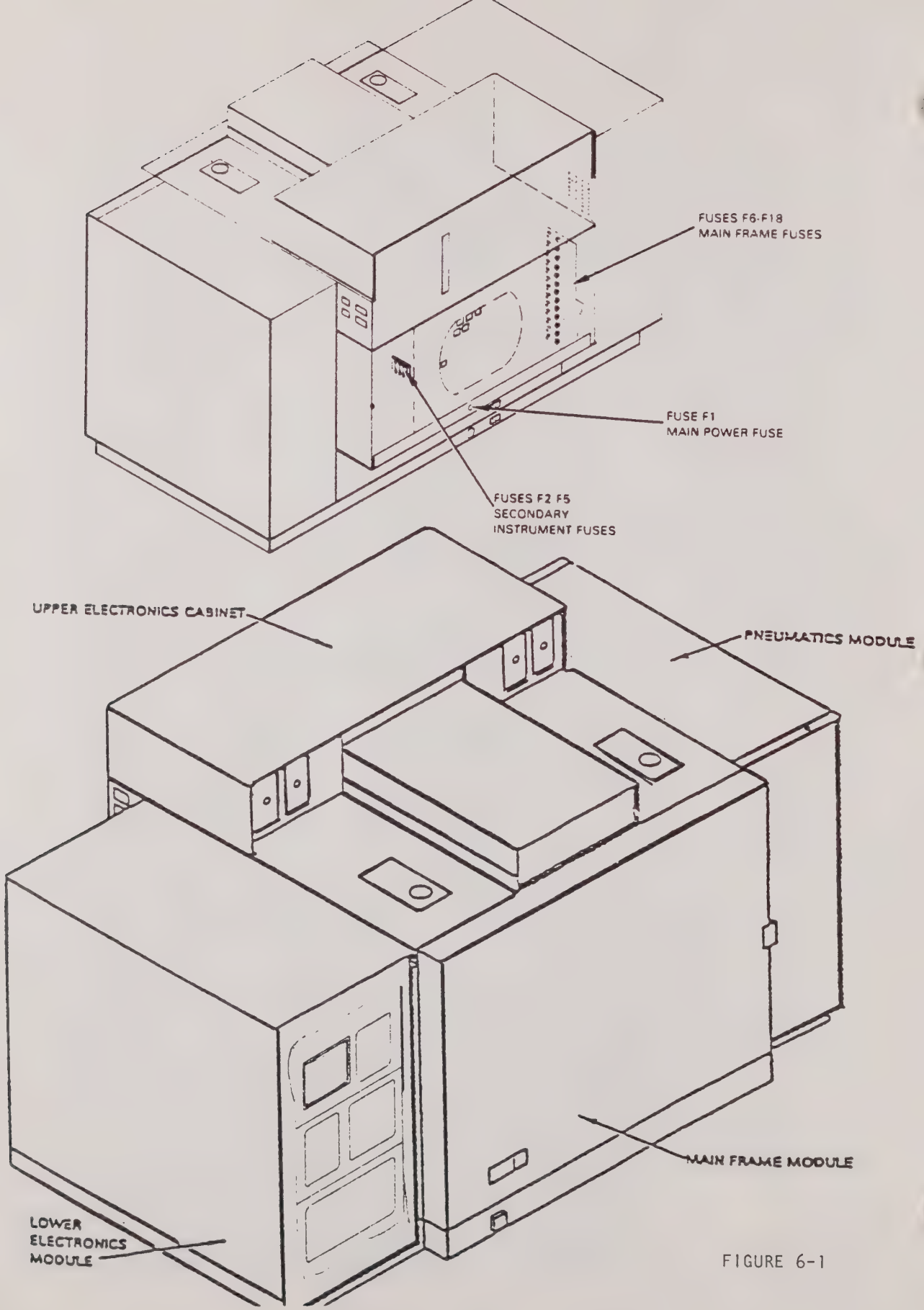

FUSES F6-F18
MAIN FRAME FUSES
FUSE F1
MAIN POWER FUSE
FUSES F2 F5
SECONDARY
INSTRUMENT FUSES
UPPER ELECTRONICS CABINET
PNEUMATICS MODULE
MAIN FRAME MODULE
LOWER
ELECTRONICS
MODULE

FIGURE 6-1

3. Printed Circuit Boards containing electronic components plug into the 100 pin connectors on the top side of this board.

b. VERTICALLY MOUNTED P.C. BOARDS - (Fig 6-2)
1. CRT and Interrupt Control and Keyboard Interface P.C.B. (J102)

2. RAM/ROM (Memory) P.C.B. (J105)

3. CENTRAL PROCESSING UNIT P.C.B. (J107)

4. Options P.C.B.'s (External Events, Auto Sampler and Parallel Serial Interface P.C.B's) can be installed in slots J109 to J115.

5. Lower Power Supply P.C.B. (J117 only)

NOTE: Order of P.C. Boards is from front to rear and may vary from instrument to instrument. The Lower Power Supply P.C. Board must be in the last connector (J117). Access to the front three boards is gained by removing the Battery/CRT module.

c. BATTERY AND CRT MODULE -
1. CRT module is not included with the Battery Charger in VISTA G.C. models 4600 and 4600B.

6.3 UPPER ELECTRONICS COMPARTMENT LAYOUT -
a. UPPER MOTHER P.C. BOARD -
1. Mounted horizontally extending from right to left of upper electronics compartment.

2. Contains only connectors and printed solder traces (no electronic components).

3. Printed Circuit Boards containing electronic components plug into the 100 pin connectors on the top side of this board.

4. Molex connectors J45,J46,J47 and J48 on the underside of this board connect to the main wiring harness in the Rear Electronics Compartment.

b. VERTICALLY MOUNTED P.C. BOARDS - (Fig 6-3)
1. Detector Interface P.C.B. (J118 only)

2. Connectors J119 to J121 are used for

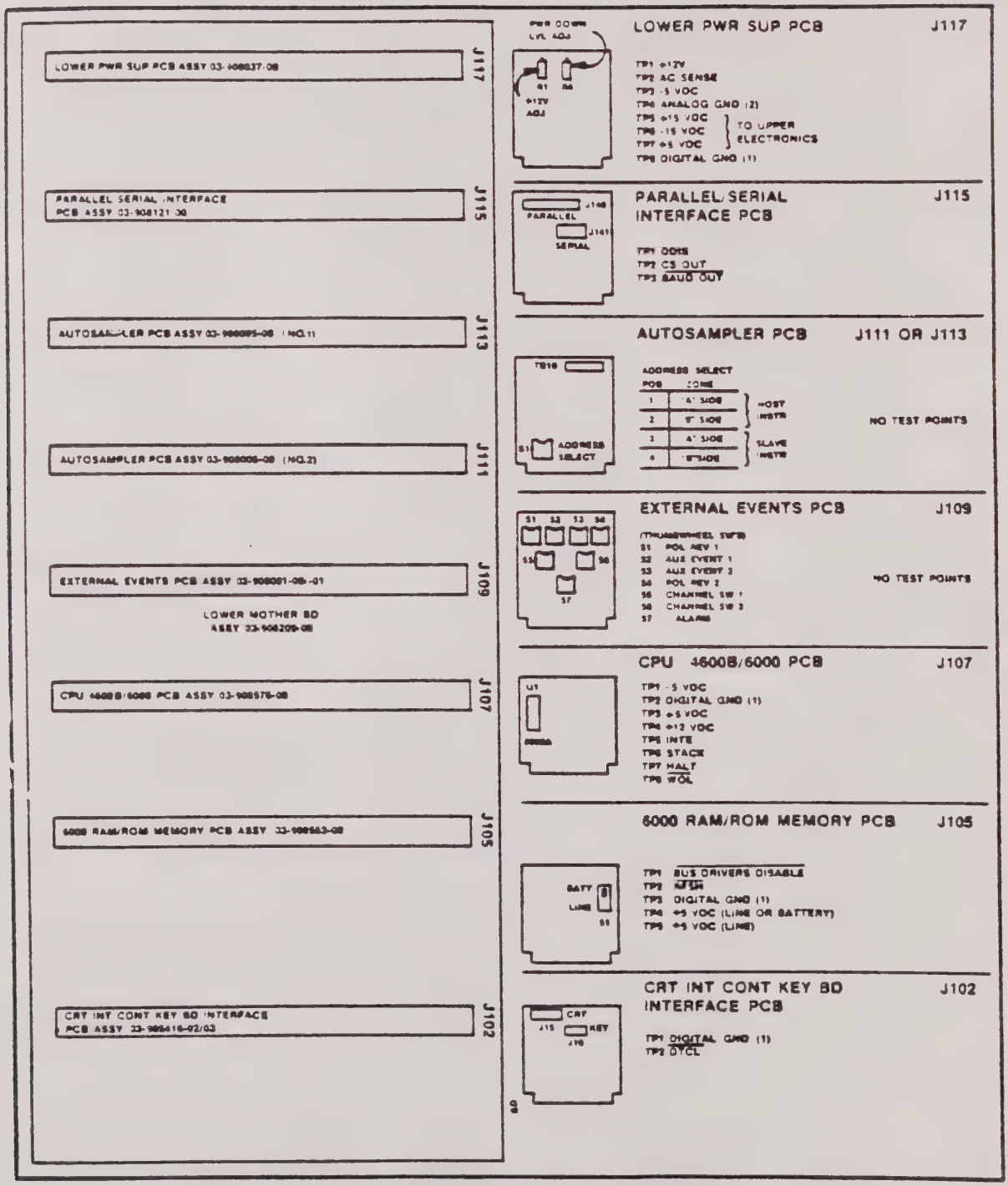


FIGURE 6-2

LOWER MOTHER P.C.B.

detector power PCB's (TCD and TSD)

3. Connectors J122 to J124 are used for detector electrometers (FID, TCD, ECD, TSD, FPD). Only three can be mounted at any one time.

NOTE: The TCD and TSD both require two PCB's for operation. The location of the electrometer module is dictated by the connector in which the power PCB is located on the mother board (J119 to J121). i.e. If a TCD power board is mounted on connector J120, the TCD electrometer MUST be mounted on Connector J123. If this spacing is not correct there will be no TCD Current control or TSD Bead Current control if a TSD is used (Fig 6-3).

4. Interconnect/Power PCB (J125 only, Used only on the 6500 G.C.

5. Probe Amplifier PCB (J126 only).

6. SSR Power Control PCB (J127 only).

7. Hi Voltage PCB (J128 only, Used only with FID and FPD).

8. Flow Sensor PCB (J129 only, Used only with Flow Sensor Option).

9. Interface PCB (Optional, Used only when a Parallel/Serial Interface PCB is installed in the lower electronic compartment).

NOTE: Order of the P.C. Boards is from left to right and may vary from instrument to instrument. The Interface PCB is mounted directly to the bulkhead at the right rear of the upper electronics compartment.

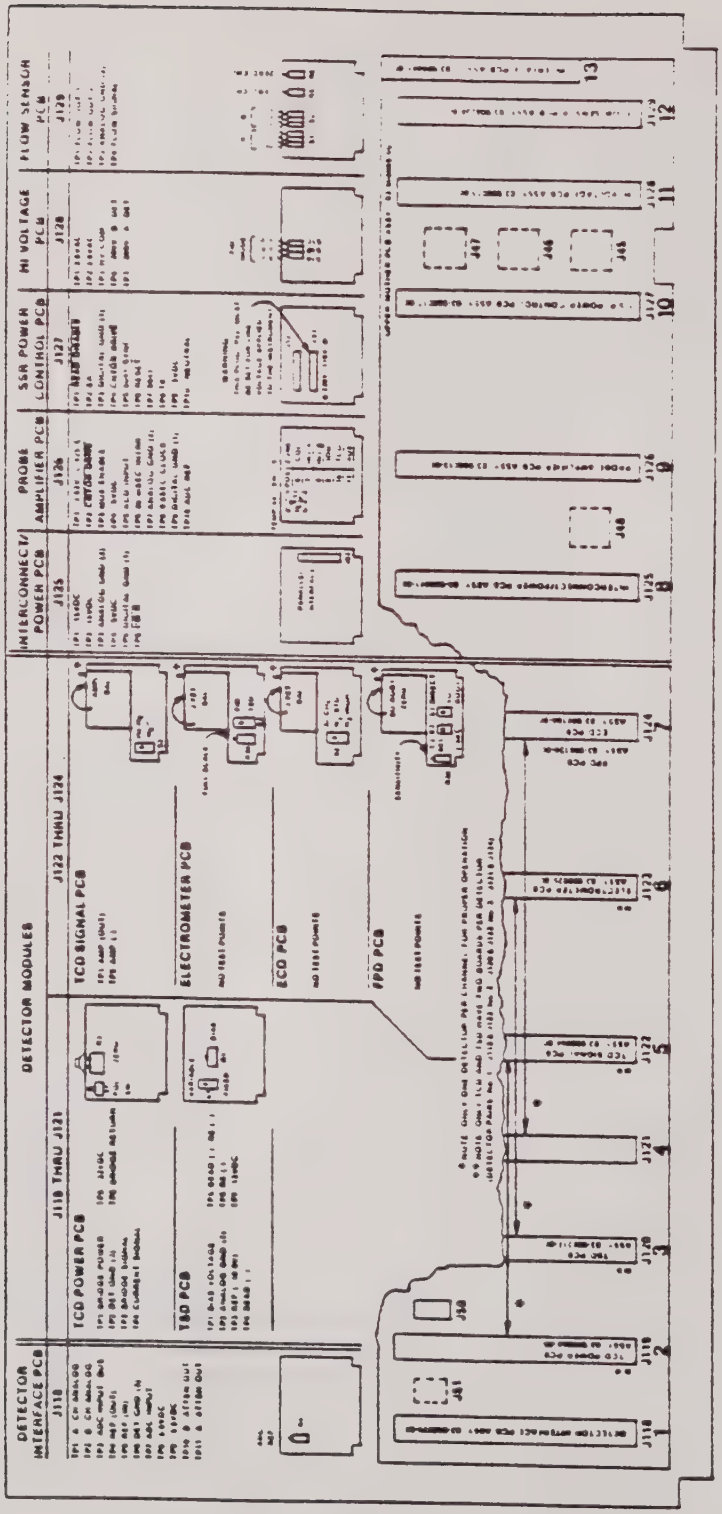


FIGURE 6-3
UPPER MOTHER BOARD P.C.B.

7. ELECTRICAL POWER AND FUSES:

7.1 Checking A.C. Power -

a. The A.C. wall receptacle should be checked for voltage levels when installing the instrument or when problems are encountered. The proper wall outlet for a VISTA G.C. is 120 VAC 20 AMP. (Figure 7-1)

b. Check the A.C. power with a V.O.M. or a D.V.M. on the A.C. voltage function at a range of 150 volts or higher.

c. Readings are to be taken between hot and ground and between neutral and ground, see Figure 7-1. If the VISTA G.C. main power on/off switch-indicator glows when the instrument has been switched off, this is an indication that the hot and neutral are reversed in the wall outlet.

NOTE: Any changes to electrical circuits must be performed by a qualified electrician.

1. Voltage readings on the hot side should correspond to the voltage tap being used on the transformer ± 10% (Figure 7-2).
2. The neutral side must be less than 3 VAC.

d. The transformer voltage tap is factory set to the 120 volt setting and in most locations will not require resetting. If the AC line voltage is too low, it may cause the AC Sense circuit to shut down the instrument. If the line voltage is consistently below 110 VAC, it is recommended that the transformer taps be relocated. The procedure for resetting the transformer tap is as follows:

Monitor the line voltage over a long enough period of time to convince yourself that the low voltage is not a temporary condition (2 working days). Do not take readings when the electrical load is likely to be changing (i.e. early morning, late in the day and at lunch time). After a voltage level has been established, turn off the power and unplug the instrument, remove the large rear cover and lower rear cover panel to access the transformer taps (Figure 7-2). Set the appropriate voltage by moving the orange and violet wires. After the tap has been moved, check and reset the A.C. Sense voltage (Reference 8-2)

e. If there is no indication of AC power at the wall outlet, check the fuse or circuit breaker

NOTE: POTENTIAL BETWEEN NEUTRAL AND GROUND SHOULD NOT EXCEED 3 VOLTS.

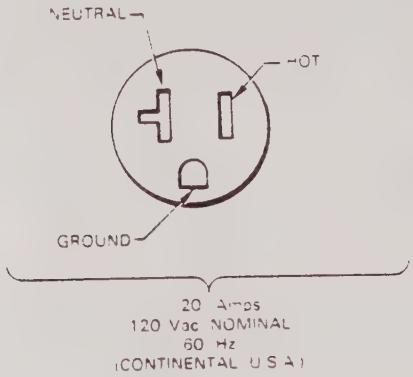


FIGURE 7-1

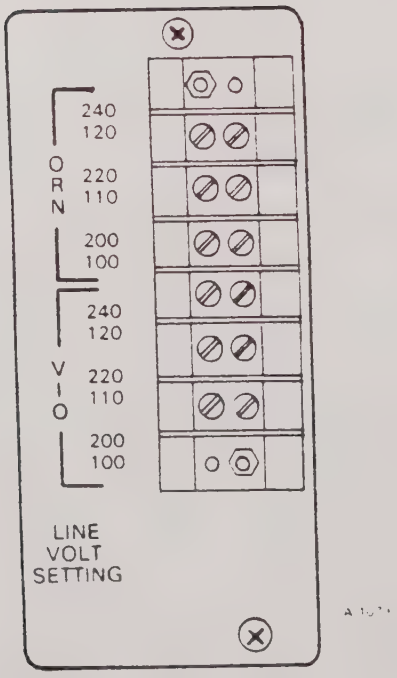


FIGURE 7-2

at the wall panel. Replace fuses as necessary. To reset circuit breakers, turn them to the off position and then return them to the on position.

f. Check the power cord plug for loose connections.

g. Check latching of the main power switch.

7.3 POINTS TO REMEMBER ABOUT FUSES -(Figure 7-3)

a. Turn off the power and unplug the power cord before checking the fuses.

b. Replace a fuse with a fuse of the same value

c. Replace a slow blow fuse with a slow blow fuse, a standard fuse with a standard fuse; replace a glass fuse with a glass fuse; a ceramic with a ceramic.

d. It is recommended that fuses be removed from the fuse block for checking. Remove, check, and replace fuses one at a time. Fuses 12 and 13 must be replaced at the same time if one is blown.

e. Check fuses for continuity with the ohm function of a volt/ohm meter or digital volt meter. Small breaks may be difficult to see or hidden from sight by the fuse ends. The condition of a ceramic fuse can only be determined with an ohm meter.

f. If a fuse is blown, replace it. If it blows again, check the condition of the fuse holder. Look for heat stains and/or a collapsed spring in the fuse holder cap which could cause a loose connection and heat build-up. If neither of these conditions exist a problem requiring the attention of a Varian Service representative is indicated.

FUSE CIRCUIT LOCATIONS

Fuse Number	Fuse Rating	Part Number	Circuit	If Blown
F1	20A* 10A**	87-131520-00 (110) 87-130510-00 (220)	Main Power	Complete instrument shutdown
F2	1.5A 250V slow blow	87-130007-00	TSD Transformer (TSD TRANS)	No heat current to TSD
F3	4A 250V slow blow	87-133444-00	Detector Heaters (DET HTR)	No power to ionization TCD ovens
F4	8A* 250V(110) 4A** 250V (220)	87-130480-00 (110) 87-133440-00 (220)	Main Transformer (MAIN TRANS)	Complete instrument shutdown
F5	4 10A 250V slow blow	87-136340-00	RAM Battery	RAM battery charger inoperative
F6	1A 250V slow blow (+5 Vdc isol)	87-135410-00	Serial Interface	System inoperative
F7	1A 250V slow blow (-5 Vdc isol)	87-135410-00	Serial Interface	System inoperative
F8	1 32A 250V slow blow (+200 Vdc)	87-135231-00	FID High Voltage	No polarizer voltage
F9	1A 250V slow blow (+32 Vdc isol)	87-135410-00	TCD Bridge Power	No bridge current
F10	1A 250V slow blow (-50 Vdc)	87-135410-00	ECD Pulser Power	No pulses from ECD
F11	5A 250V, slow blow, (3.8 Vac)	87-137450-00	Ignitor Power	No flame ignition
F12	1.5A 250V, slow blow (-15 Vdc)	87-130007-00	-15 Vdc for instrument	System inoperative
F13	1.5A 250V, slow blow (+15 Vdc)	87-130007-00	+15 Vdc for instrument	System inoperative
F14	1A 250V slow blow (-5 Vdc)	87-135410-00	-5 Vdc for instrument	System inoperative
F15	3A 250V, slow blow (+12 Vdc)	87-135430-00	+12 Vdc for instrument	System inoperative
F16	20A 250V (+5 Vdc)	87-131520-00	+5 Vdc for instrument	System inoperative
F17	3A, 250V slow blow (115 Vac)	87-135430-00	115V for External Events and A/S PCB's and rear power receptacles	External Events and A/S PCB's and rear power receptacles inoperative
F18	1.5A 250V slow blow (220 Vac)	87-130007-00	220V for External Events and A/S PCB's and rear power receptacles	External Events and A/S PCB's and rear power receptacles inoperative

*Nominal 100-120 Vac line voltage **Nominal 220-240 Vac line voltage

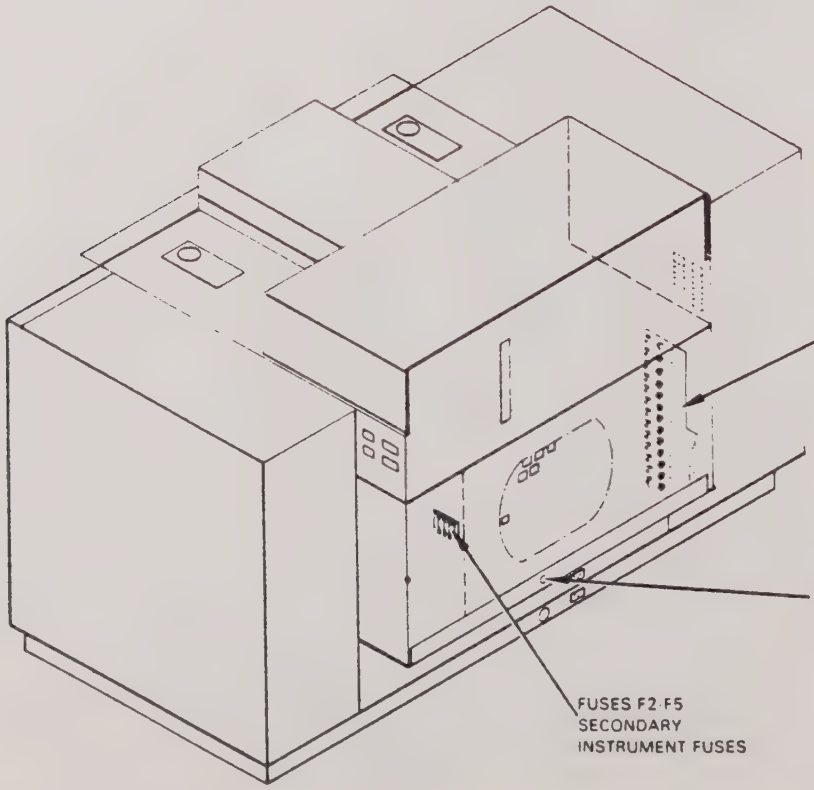


FIGURE 7-3

8. TEST POINTS, VOLTAGE CHECKS, ADJUSTMENTS AND CALIBRATIONS:

Test point voltages and other voltage measurements are the first step in the location of a malfunction. Test points are usually monitored and voltages measured with respect to a specific ground or neutral point. The following is a description of the various measurements and associated adjustments within the VISTA GC system.

8.1 POWER SUPPLY AND INTERCONNECT PC BOARD (Figure 8-1)

The Power Supply and Interconnect PC Board is physically located in the lower electronics compartment and is the last PC Board from the front of the instrument. It can be functionally divided into three sections:

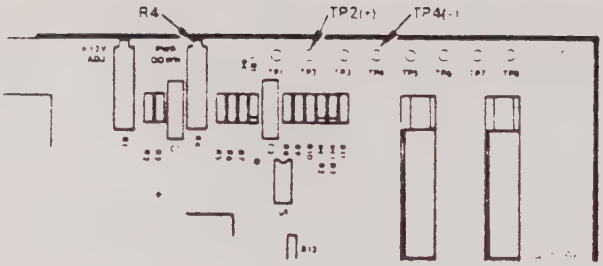
a. Regulated DC Supply:
   1. Set the column oven Fan/Fan Heater switch to Fan only
   2. Check the voltages with your DVM to verify the following values:

TEST POINT	SUPPLY	ACCEPTABLE RANGE	ADJUSTMENT
* TP5	+15VDC	+15V±0.75VDC	
* TP6	-15VDC	-15V+0.75VDC	
** TP1	+12VDC	+12V±0.2VDC	R-1
** TP7	+5VDC	+5V+0.25VDC (+5VDC regulator located on chasis)	
** TP3	-5VDC	-5V±0.25VDC	

* These measurments are with respect to TP-4 (GND)
** These measurments are with respect to TP-8 (GND)

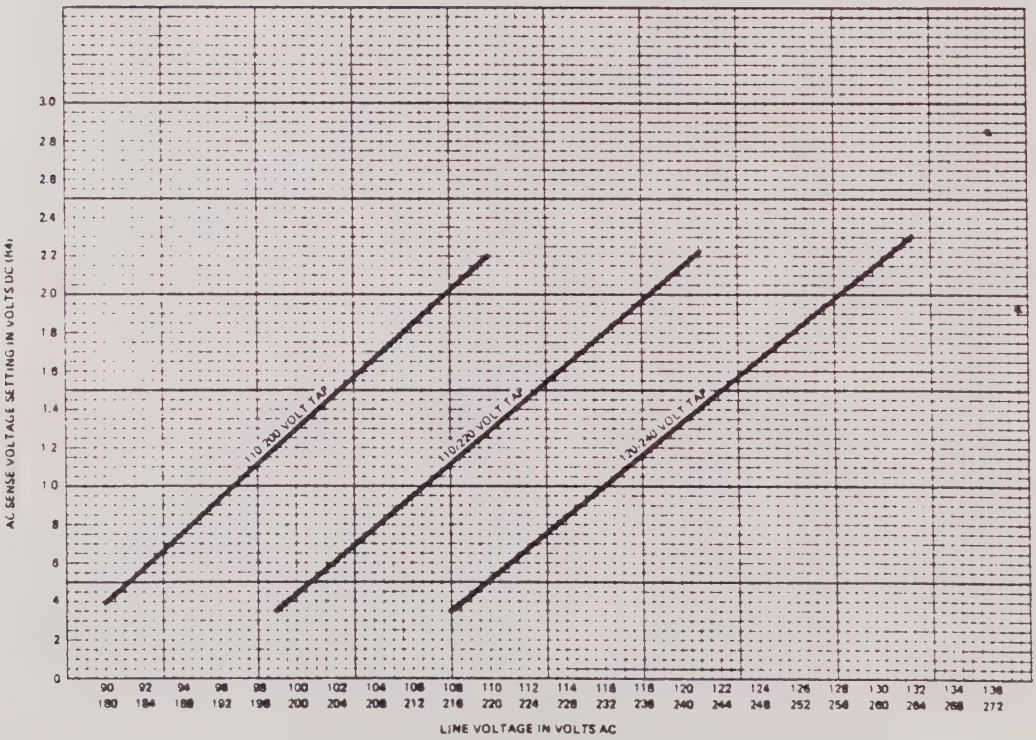
NOTE: If an unadjustable voltage is found to be incorrect, the problem is beyond the scope of this course and a Varian Service Representative should be contacted.

b. AC Sense:
   1. Measure AC line voltage.
   2. Select the transformer tap (Fig 7-2) that is within +10% of the line voltage.
   3. Establish the AC Power down reading from Fig 8-2.
   4. Read the voltage on T.P. 2 (Ref T.P. 4)



POWER SUPPLY AND INTERCONNECT PC BOARD

FIG. 8-1



AC SENSE VOLTAGE TABLE

FIG. 8-2

and adJust R-4 to readinG estaclished in Step 3.

c. Bus Interconnect Circuits:
1. Two flat cables connectinG the lower electronics compartment to the upper electronics compartment via the Detector interface PCB.

8.2 BATTERY CHARGER AND ROM POWER SUPPLY -(Fig 8-5)
a. 9.2 VDC T.P. 1 (Ref. chassis ground)
1. AdJust R-2 for a readinG of +9.2 VDC +/-.1 VDC

8.3 DETECTOR INTERFACE PCB -(Fig 8-4)
a. 0.1024 VDC T.P. 4 (Ref out) & T.P. 5 (Ref in)
1. AdJust R-4 for a readinG of 0.1024VDC

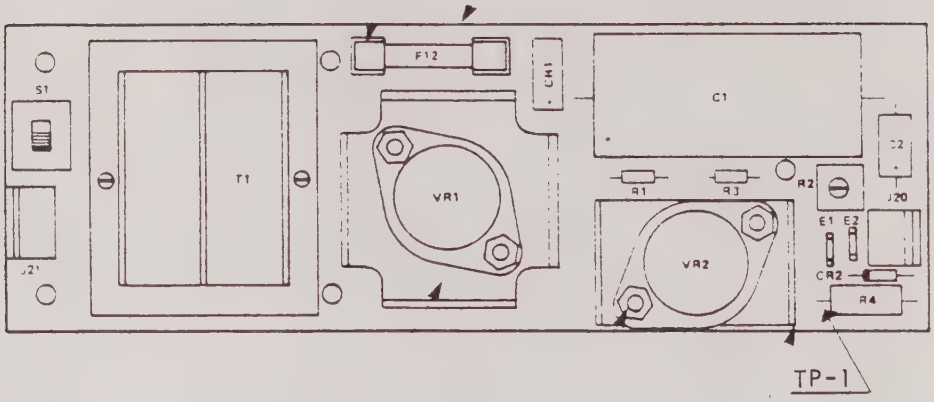
8.4 PROBE AMPLIFIER PCB -(Fig 8-5)
a. HEATER/PROBE LOGIC LEVEL CHECK
1. Connect T.P. 2 (logic level of 0 or +5VDC) and T.P. 9 (Reference ground).
2. Perform a Cold Start and measure a Hi or low voltage. (0 or +5VDC)
3. If the readinG measures nearly 0 VDC, (low) the Probe Amp Board is workinG and the C.P.U. is all right. If the readinG is +5VDC (high), a problem exists in either the Probe Amp PCB, SSR PCB, CPU PCB, or in a heater/probe assy.

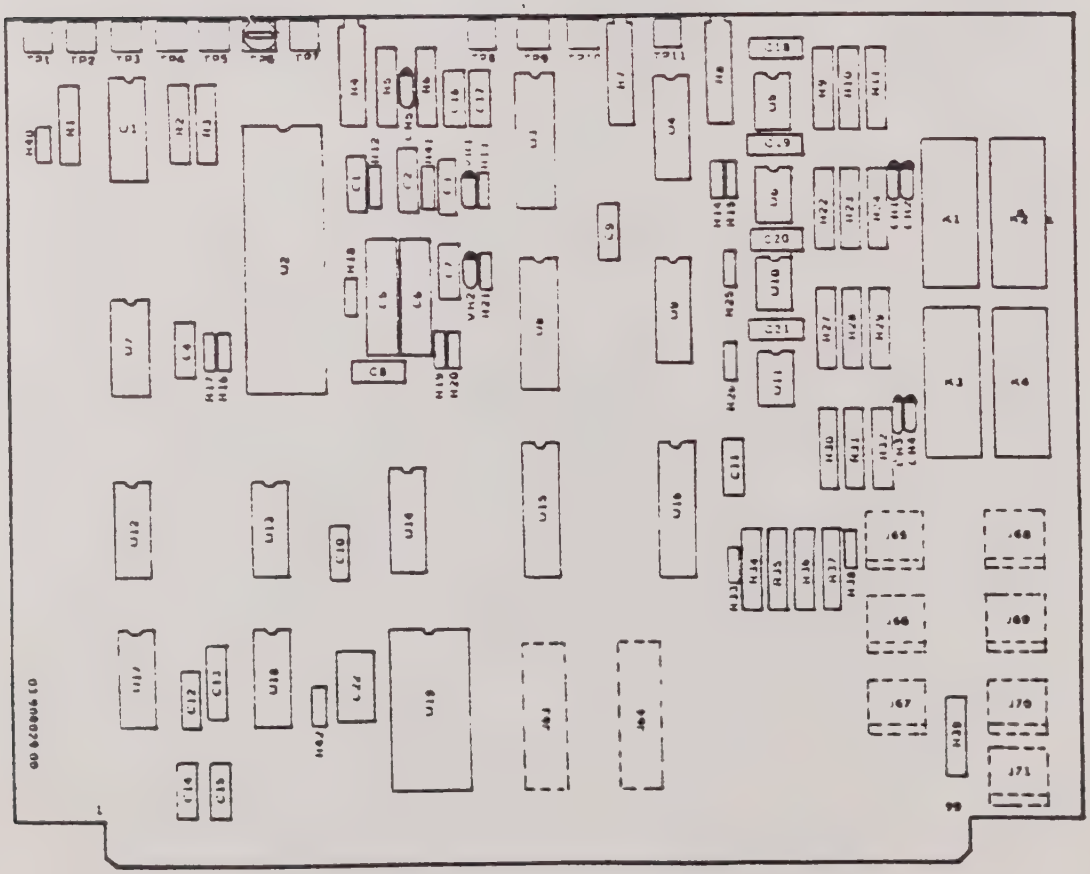
8.5 LED DISPLAY CHECK -(Fig 8-6)
a. The front panel LED display will indicate the correct functions on "power up" of the CPU, RAM/ROM, Interrupt/Controller and the PARALLEL/SERIAL P.C. Boards. Also, it will show malfunctions of these boards, dependinG on which LED's are lit. The "NOT READY" A+B and the "AUTOZERO" A+B LED's are the only indicators which should be on durinG power up. If any LED's flash or if all LED's are off, there is an error.

NOTES:

BATTERY CHARGER AND ROM POWER SUPPLY

FIG. 8-3



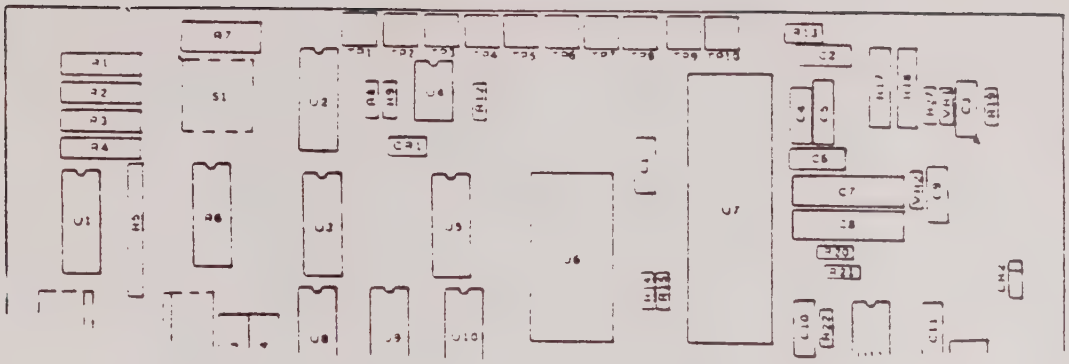


DETECTOR INTERFACE PCB

FIG. 8-4

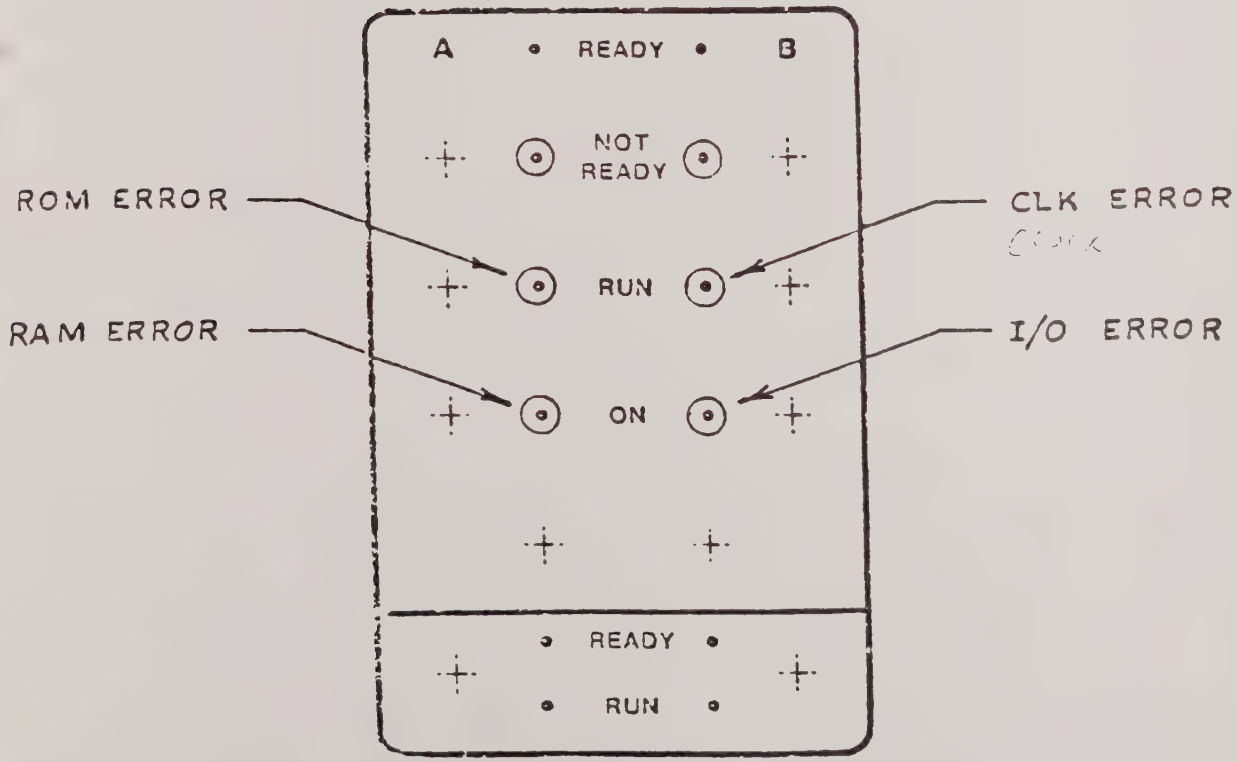
PROBE AMPLIFIER PCB

FIG. 8-5



LED DISPLAY CHECK

FIG. 8-6



SECTION 9: VISTA G.C. Electrical and Electronic Troubleshooting Circuit Descriptions:

Sub-Section	Circuit	Page(s)
9.0	General	14-16
9.1	Lower Power Supply	17-18
9.2	Battery Charger & RAM Power Supply	19
9.3	C.R.T Module	20
9.4	Keyboard Assembly	21
9.5	C.R.T. Interrupt control & Interface PCB	22
9.6	RAM/ROM PCB	23
9.7	Central Processor (CPU)	24
9.8	Autosampler control PCB	25
9.9	External Event PCB	26
9.10	Parallel/Serial PCB	27
9.11	Detector Interface PCB	28
9.12	Interconnect power PCB	29
9.13	Probe Amplifier PCB	30
9.14	SSR Power control PCB	31
9.15	Flow sensor PCB	32

9.0: GENERAL -

a. Care of the equipment -
The VISTA SERIES G.C. as well as other instruments and equipment operate more reliably and have a longer life if care and precautions are followed when using the equipment. The following is a list of some of these precautions and suggestions for proper instrument care.

1. Do not store or place chemicals, coffee, soft drinks, etc. where they will spill into the instrument (including instrument vents).

2. Keep instrument clean; remove dust from P.C. Boards, air inlets or outlets, and other parts of the instrument with clean, DRY air or nitrogen. Make certain cooling fan is operating.

3. Do not pinch cables or wires in doors, panels, covers, etc.

4. Handle P.C. Boards as well as mechanical parts carefully. Many circuit boards with microprocessors, memory I.C.'s and other devices are static sensitive. Handle these boards by the edges; if they are taken out of the instrument, place them on conductive plastic. Ship circuit boards in conductive plastic bags or wrap; DO NOT ship boards in styrofoam without a conductive plastic bag or wrap.

5. Periodicaly check for incications of wear or overheating (i.e. heat stains on P.C. boards).

6. Have a qualified service representative perform a Preventative Maintenance inspection and check out about once a year. These inspections can be accomplished when the service representative is in your area; this will reduce the cost of travel charges. A preventative maintenance inspection can provide valuable up-time as well as prevent more costly repairs by diagnosing problems in their early stages; thus, preventing additional circuit damage from components not operating within specified tolerance ranges. Varian Instrument Division performs preventative maintenance inspections on equipment covered by service contracts as a means of cost savings and to provide the user

maximum up-time for the equipment.

7. There are many calibrations, checks, and repairs covered in this course; more complex problems should always be resolved by a Varian Service Representative.

b. Electrical precautions -

1. When removing or installing panels, fuses, circuit boards, power supply components, or performing other tasks with a protective metal cover removed, turn off the instrument power at the main switch and unplug the instrument. The only time the instrument should be plugged in and powered up with the protective panels removed, is when it is necessary to perform voltage checks or measurements inside the instrument.

2. Whenever possible work with one hand when the instrument power is on and voltage measurements are being taken or adjustments being made. Keep the other hand away from the instrument frame and away from any ground source.

3. Do not let yourself become complacent when working inside an instrument with power on.

4. Always use insulated tools for adjustments inside the instrument when power is on.

5. Do not remove or insert circuit boards or modules when power is on.

c. Volt ohm meters -

1. When using the ohm function, touch the meter leads together to insure operation. Zero resistance should be read out on a D.V.M.. An analog volt ohm meter should be adjusted to zero on the scale that is being used.

2. When using A.C. volts function, the position of the meter leads should be black lead into common receptacle red lead into volt/ohm receptacle. The meter leads can be reversed when using the A.C. scale; it is just a good practice to keep the leads in their respective order.

3. When using the D.C. Volts function, the black lead must go to common and the red to positive to determine correct polarity. Most digital meters display a - when D.C. Voltage is negative. Analog meters must either be

equipped with a polarity reversal switch or the leads must be physically reversed to read negative D.C. voltage values.

4. When taking voltage readings, take initial readings at the higher value ranges and reduce range values as necessary for the most accurate readings. (some of the newer meters have an auto range feature).

d. Electronic nomenclature and information -

1. When a voltage value is stated without A.C. or D.C., assume voltage is D.C.

2. When D.C. voltage is not preceded by a sign, assume it to be positive.

3. When taking resistance (ohms) measurements and comparing to a listed value, look for a multiplier such as K(1000), after the numerical value. If none exists, assume it to be ohms times one.

4. A larger wire size or resistor size (physical size) indicates higher current.

e. Other -

1. When adjusting potentiometers inside the VISTA SERIES G.C., be sure you have the correct pot on the correct P.C. Board.

9. CIRCUIT DESCRIPTIONS:

9.1:LOWER POWER SUPPLY P.C. BOARD (Fig 9-1) -

a. Regulated DC Supplies

1. The regulated DC voltage produced are:

+15VDC (±5%)
-15VDC (±5%)
-5VDC (±5%)
+12VDC (±.2VDC) (adjustable
+5VDC (±5%)

2. +15VDC

VR2 and VR3 provide regulation within 5% of the nominal 15v outputs. Current limitations are 1/2a each regulator. Protection is provided by fuses F13 (1.5a) and F12 (1.5a).

The +15VDC AC input is also fed to the AC Sense Ckt where it is full wave rectified and used to monitor the condition of the AC input.

3. +12VDC

VR1 regulates the nominal 18.3VDC input from CR4 and produces a +12VDC adjustable output. The voltage should be set to 12VDC +.2VDC using R1. Fuse F14 (3a) provides fault protection.

4. -5VDC

UR4 regulates the nominal -9.5VDC input from CR5 and provides the -5VDC regulated output. Fuse F14 (1a) provides fault protection.

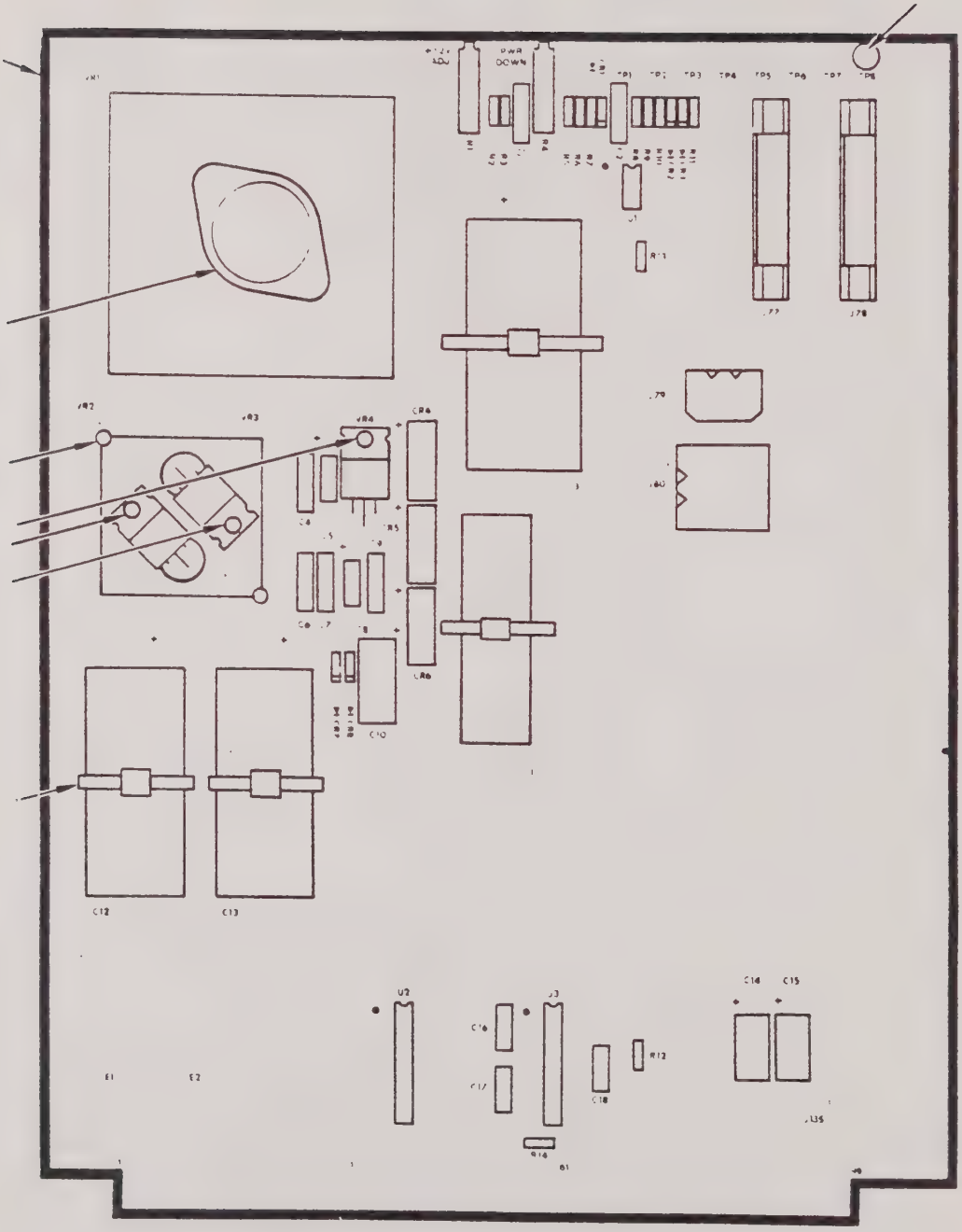
5. +5VDC

The +5VDC regulator is physically located on the exterior of the rear panel of the instrument. 10.7VDC is the nominal supply for the regulator and is produced by a bridge rectifier also located on the external heat sink. This supply is rated for 8 amps nominal and is fused by F16 (20a).

b. AC Sense Circuit

Although very similar to the LC5000 AC Sense Circuitry, the Graphs used to set sense level are different.

The incoming line voltage is sampled by CR7 and CR8 which supply a full wave rectified voltage to C10. C10, R5, R4, and R6 produce a



LOWER POWER SUPPLY PCB

FIG. 9-1

120HZ sawtooth waveform that is shifted negative by R6 being connected to the -15v supply.

As long as the AC line is present the voltage at TP2 is approximately +1VDC. When the AC line voltage is not present TP2 will go negative which causes the output of U1 to go positive. This reverse biases CR2 and causes the AC Sense output to go high indicating a power fail. Hysteresis is provided by positive feedback to U1 such that a charge of 5VAC must occur to cause AC Sense to go low.

Refer to the calibration procedure for circuit adjustment. (Section 8.1)

c. Upper/Lower Bus Interconnect:

The lower portion of the board is used for microprocessor bus connections between the lower and upper mother boards.

These connectons are made at the upper right corner of the board with two bidirectional flat cables connected to the Detector Interface PCB in the upper electronics compartment.

d. Key Points -

1. Access to the Power supply PC Board is gained by removing the lower electronics cover.

2. The only adjustments on this board are the 12VDC (TP1 ref TP3 adj R1), and the AC Sense (TP2 ref TP4 adj R2).

3. If it becomes necessary to replace the 5VDC regulator , it is mounted on the black metal heat sink at the back of the instrument electronics. Be certain that this component is held well with the appropriate hardware (This insures proper component cooling).

NOTES:

9.2 Battery Charger and RAM Power Supply (Fig 8-5) -

a. The battery and the battery charger/RAM power supply is located on the right-hand side of the CRT module.

b. Function: This power supply provides the 5VDC necessary to generate and preserve RAM memory; the battery is always charging when power is applied to the instrument at the wall outlet and the main frame battery switch is in the on position. The battery, when new, can supply six to eight hours of memory protection during a power failure.

c. Test Points: TP-1 (Ref. to ground) should be set using R-2 to 9.2 VDC + .1VDC.

d. Key Points -

1. The 115VAC input is not controlled by the instrument on/off switch.
2. Fuse F-12 is located on the charger PC Board. This fuse should not be confused with F-12 mounted on the fuse block inside the instrument.
3. The main frame battery switch must be set to the on position for battery charging. This switch should be turned off if the power cord is disconnected for over eight hours; this is to prevent the battery from discharging to a point where it cannot be recharged.

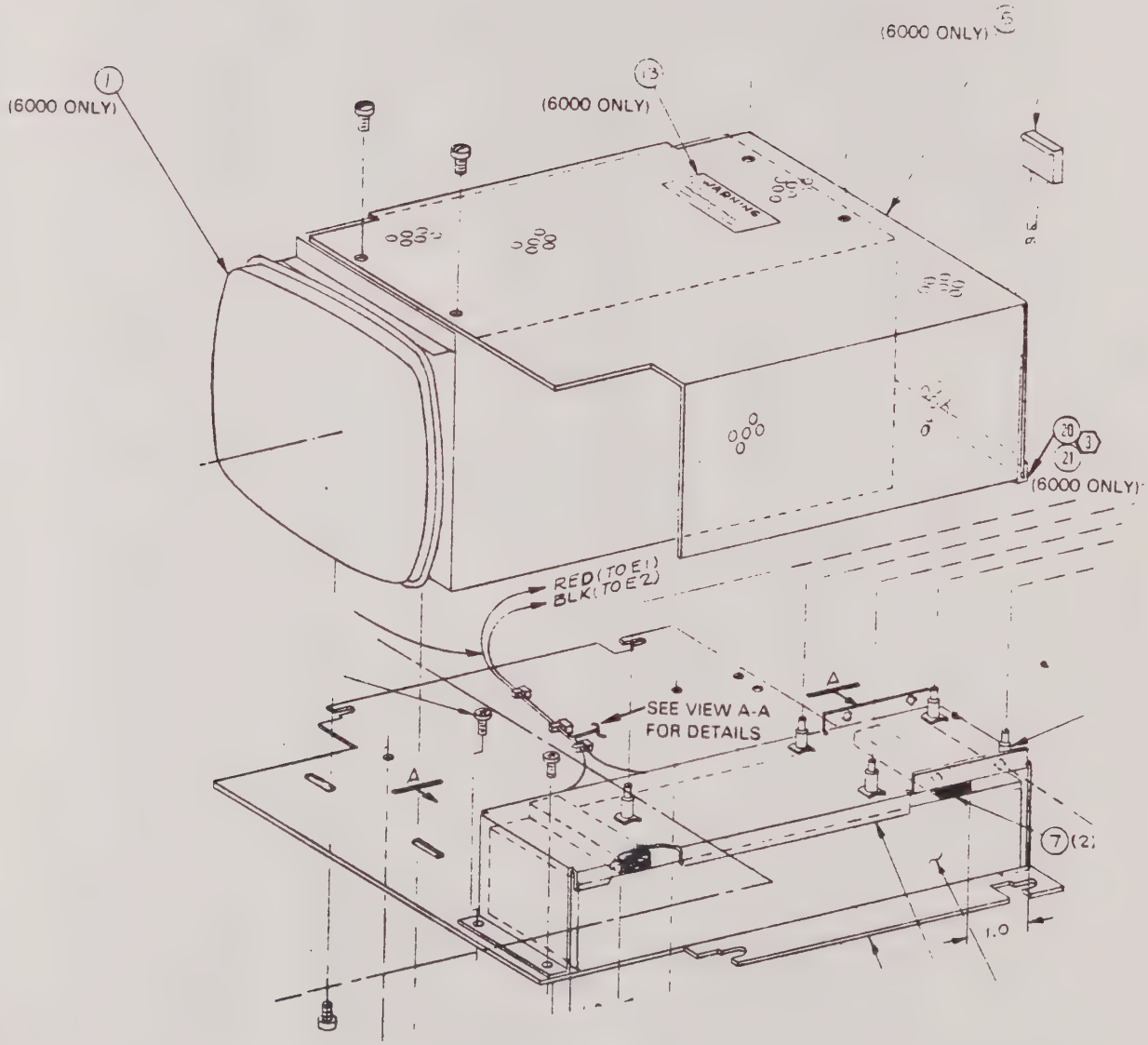
NOTES:

9.3 C.R.T. Module - (Fig 9-2)

a. The C.R.T. screen is only used to monitor parameters and system conditions; however, if a display is absent it does serve as an immediate indicator of memory or voltage supply problems in most cases. The keyboard assembly is simply the device used for parameter entry and G.C. system control in the absence of a CDS-401 or 402 data system. A model 4600 or 4600B does not have a keyboard or a C.R.T. monitor, it must be used in conjunction with a CDS-401 or 402 data system.

b. C.R.T. adjustments -
WARNING! There are dangerous voltages present in the C.R.T. module when power is applied and after power has been removed. There are a limited number of adjustments that will be covered; however, repair should not be performed on the C.R.T. module. There are exchange modules available at an exchange price from the Varian Service Center in Sunnyvale, California. When handling the C.R.T. module, be careful not to drop or bump the C.R.T. and do not scratch the C.R.T. screen; an implosion hazard exists. Power for the C.R.T. module is provided by the +12VDC power supply on the Power supply PCB. The +12VDC supply and and the signals generated by the memory P.C.Board and the C.P.U. printed circuit board route to the C.R.T. display through J-15 of the C.R.T./interrupt P.C. Board. The normal user adjustments are for focus and brightness; these adjustment "pots" are located at the very rear of the module on the left-hand side. (When the C.R.T. module is viewed from the rear). These adjustments must be made with a non-conducting screwdriver. An adjustment to the focus need only be made when required to distinguish characters. Brightness should be at a level so the screen can be easily read, but do not keep the screen too bright; this is hard on the user's eyes and will, in time, etch the C.R.T. screen.

NOTES:



CRT MODULE
FIG. 9-2

9.4 Keyboard Assembly -

a. The keyboard is a single piece unit with thirty momentary closure switches. All thirty of these key positions are used on all keyboards. There is also a keyboard lockout on the underside of the keyboard panel which renders the keyboard inoperative except for instrument parameter monitoring. When the lockout switch is used, to prevent accidental changes to a users method or unauthorized access to a method by others, a display "lockout switch on" will display in the lower right corner of the C.R.T. display. Only two connections exist between the keyboard and the 6000 system. A multi-colored ribbon connector plugs into the J-16 connector of the C.R.T. interrupt control P.C. Board. The keyboard enable signal is generated in the front panel keyboard (next to C.R.T. monitor) and routed to the lower keyboard via a two conductor cable.

b. The only malfunctions caused by the keyboard panel would be the non-recognition of a specific key or non-recognition of all keys. Single key failure can either be the key switch itself or a break in the multi-colored ribbon cable. A non-recognition of all keys could be caused by:

1. Keyboard lockout switch is on
2. Cable from keyboard lockout unplugged or incorrectly plugged in
3. Ribbon cable not plugged in
4. Defective interrupt P.C. Board
5. Defective CPU P.C. Board

NOTES:

9.5 C.R.T. interrupt control and keyboard interface P.C.B (C.R.T. and interface P.C. Board for short)(fig 9-3)

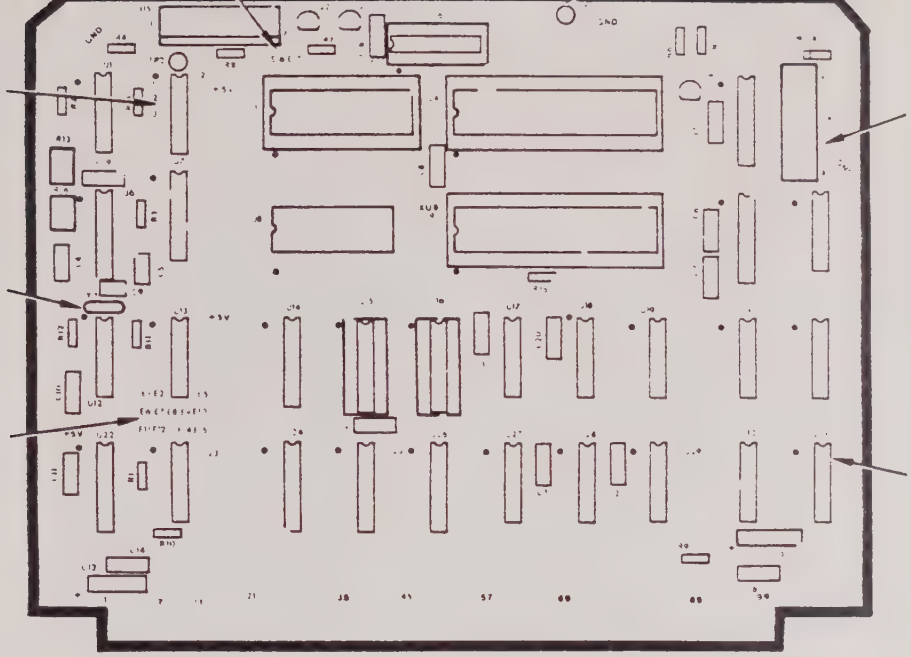
a. This P.C. Board is located inside the lower electronics compartment. It is under the C.R.T./battery charger module in the first connector position of the Mother Board. As its name implies, this circuit board performs several functions. It processes interrupts and is the interface, or allows communications between the microprocessor and the following:

1. The keyboard
2. The CRT display
3. Any automations (CDS-401/402, and AutoSampler)

b. Keypoints -

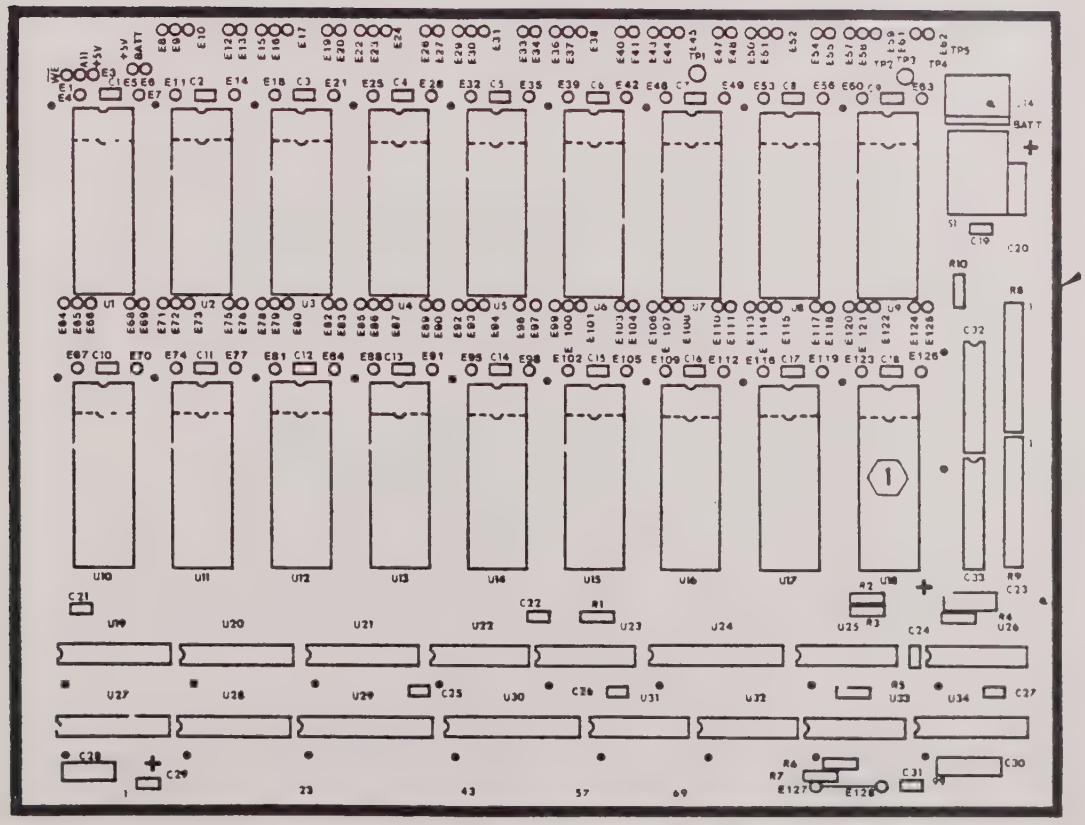
1. This and other vertically mounted P.C Boards are removed by lifting the white levers on each side of the P.C. Board.
2. When reinstalling a P.C. Board, push on top of the board, after positioning the boards with respect to the connector, until it snaps into the 100 pin connector.
3. The translucent molex connector, J-15, feeds the C.R.T. display module.
4. The flat ribbon cable from the keyboard plugs into connector J-16. The Pin #1 indicating arrow points downward; do not damage pins when plugging in connector J-16.
5. Check these cables when the C.R.T. module has been moved, be sure all connectors are in place and fully seated.

NOTES:



CRT & INTERRUPT CONTROLLER KEYBOARD FIG. 9-3

RAM/ROM PCB FIG. 9-4



9.6 RAM/ROM Printed Circuit Board - (Fig 9-4)

a. The RAM/ROM (memory) P.C. Board is located inside the lower electronics compartment under the C.R.T./charger module and is the second P.C.Board from the front of the instrument.

b. The ROM portion of this P.C. Board contains the basic commands that provide the method format and the initial C.R.T. displays. The parameters necessary for the most basic operational method is contained in the ROM (presets). The value of some of these parameters may be changed with RAM. The basic structure of ROM is not accessable to the user. The RAM contains the memory modifications entered by the user to build the desired method.

c. Keypoints -

1. Connector J-14 is where the 5 VDC from the battery adjoins the memory P.C. Board. The 5 VDC from the Battery/charger module is provided to hold the user entered method(s) and the user entered method modifications in the event of a power failure. After a short power failure occurs, a method will come back running if the program was running when the power failed. A new battery will hold the memory for about 6 to 8 hours if the battery was fully charged when the power failed.

2. The main frame battery switch must be in the on position for the battery to preserve memory. When the instrument is being shipped or the power plug is disconnected for more than 8 hours, or for any other reason, turn this switch to the off position so the battery will not discharge beyond recharging.

3. If the C.R.T. module has been moved, be certain the 5 volt connector at J-14 on the ROM P.C. board is in place and tight before reinstalling C.R.T. module.

9.7 Central Processor Unit (C.P.U.) P.C. Board (Fig 9-5)

a. The Central Processor Unit P.C.B. is the third board from the front of the VISTA SERIES GC instrument, inside the lower electronics compartment. The C.P.U. circuitry controls all of the following systems in the VISTA GC system. -

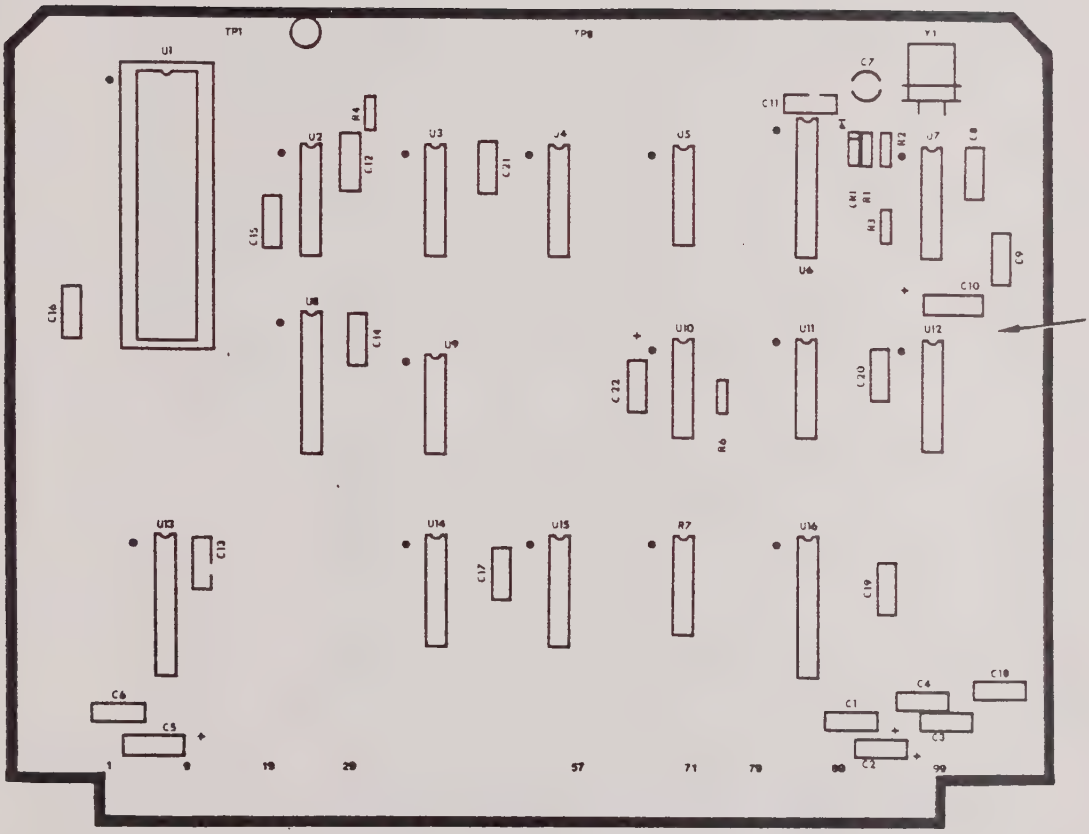
1. Temperature Control
2. C.R.T. display
3. All read-write commands (keyboard)
4. Options that interface with VISTA GC's
   automations (data systems and AutoSampler)
   event relays

b. The system clock is also on the C.P.U. Board.

c. These points of interest -

TP-1 (Ref. TP-2) - -5VDC
TP-3 (Ref. 5 volt common) +5 volts
TP-4 (Ref. TP-2) +12VDC

NOTES:



C.P.U. PCB FIG (9-5)

9.8 AUTOSAMPLER CONTROL PCB (OPTIONAL) (Fig 9.6)

a. The Autosampler PCB is basically a hardware interface between the microprocessor and the autosampler injection module.

b. All of the dicision-making logic is contained in the VISTA GC software.

c. The PCB contains SSR's to activate solenoids in the injection module and an input port to read the microswitches which tell the CPU of injection module status.

d. The heart of the Board is the 8255A, A programmable peripheral interface chip with 3 eight bit I/O ports. The chip must be initialized on power-up to determine port status.

e. U8 is the address decoder. S1 (thumb switch) selects the address of the autosampler depending on the physical position of the injection module.

f. Keypoints -

1. The autosampler will not work if S1 is not set correctly.
2. Wire connections at TB10 control the 115V AC outlets on the back of the instrument (Fig 9-7)

NOTES:

AUTOSAMPLER PC BOARD FIG. 9-6

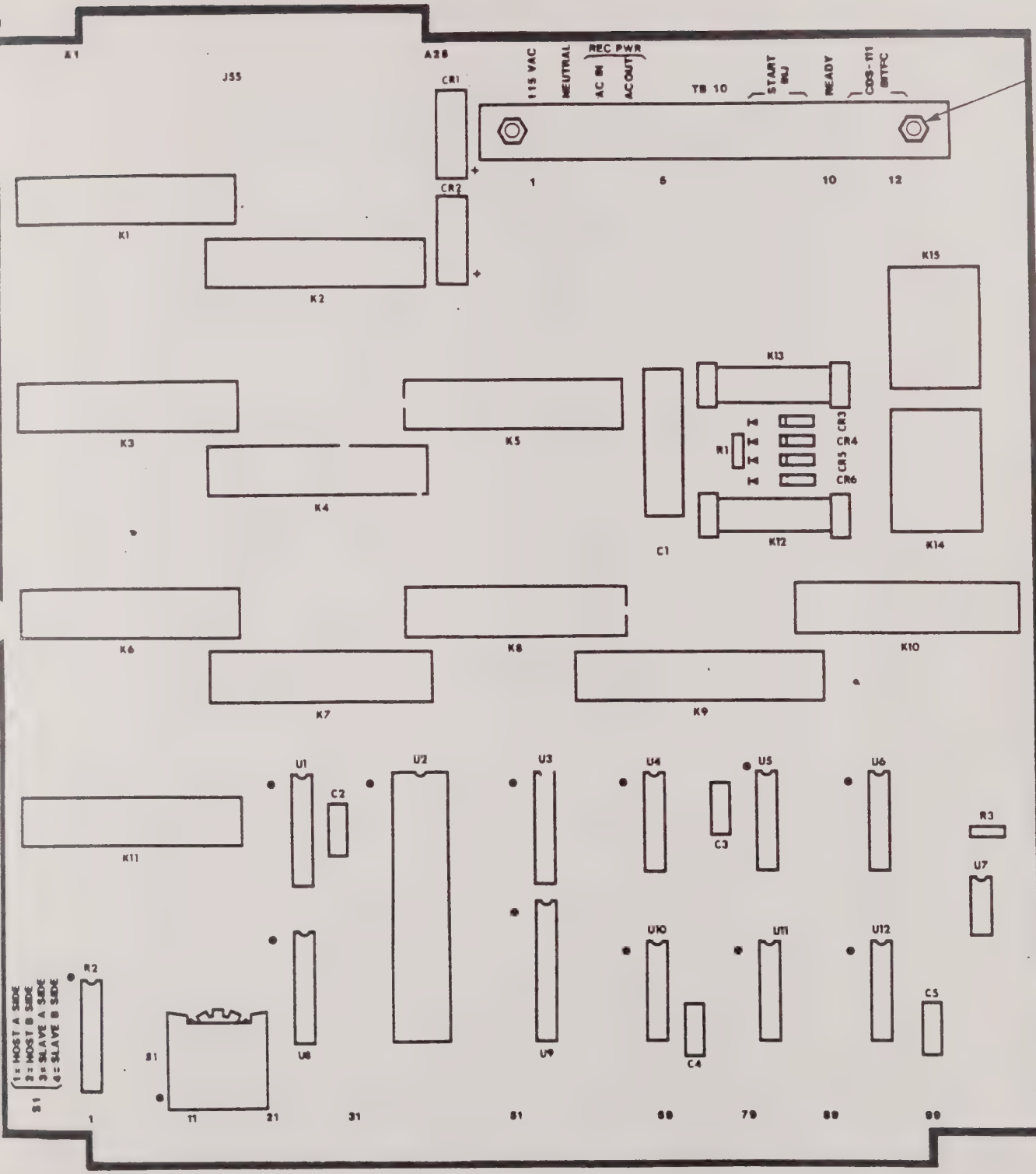


FIG. 9-7

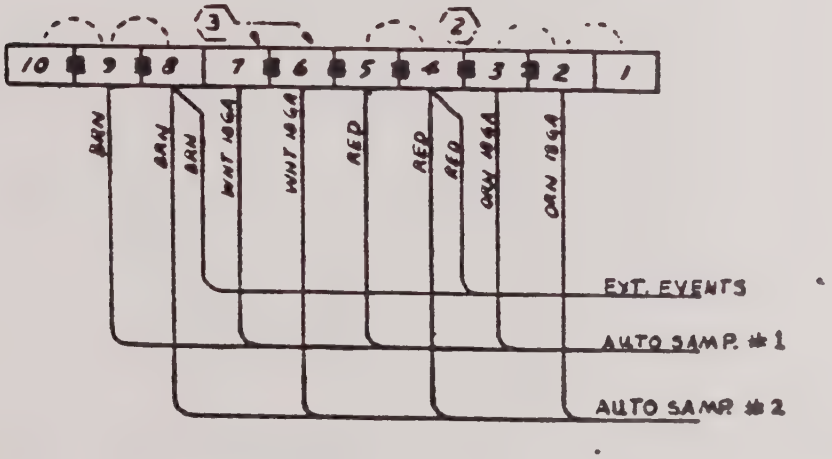
Auto Sampler - four wire harness (1 each RED, 1 each BROWN, 1 each WHITE, 1 each ORANGE) to TB10 on PCB.

TB10-1 ("115 VAC") - RED

TB10-2 ("NEUTRAL") - BROWN

TB10-3 (AC IN } Rec. Pwr.) - WHITE

TB10-4 (AC OUT } Rec. Pwr.) - ORANGE



TO INSTALL AUTOSAMPLER #1: REMOVE JUMPER ON TB9 BETWEEN TERMINALS 6 & 7. TO INSTALL AUTOSAMPLER #2: REMOVE JUMPER ON TB9 BETWEEN TERMINALS 5 & 6.

NOTE: TB-9 IS LOCATED IN THE REAR ELECTRONICS COMPARTMENT ON THE FAN MOTOR BULKHEAD, ABOVE THE MAIN TRANSFORMER

9.9 External Event PCB (OPTIONAL) (FIG 9-8)

a. The External Events PCB is a power interface between the microprocessor and the physical world. The board has the ability to activate up to 8 time programmed events.

b. The events consist of eight solid state relays to control A/C solenoids, two channels of detector polarity reversal and channel switching relays, two contact closures for auxillary events and an audible alarm indicator.

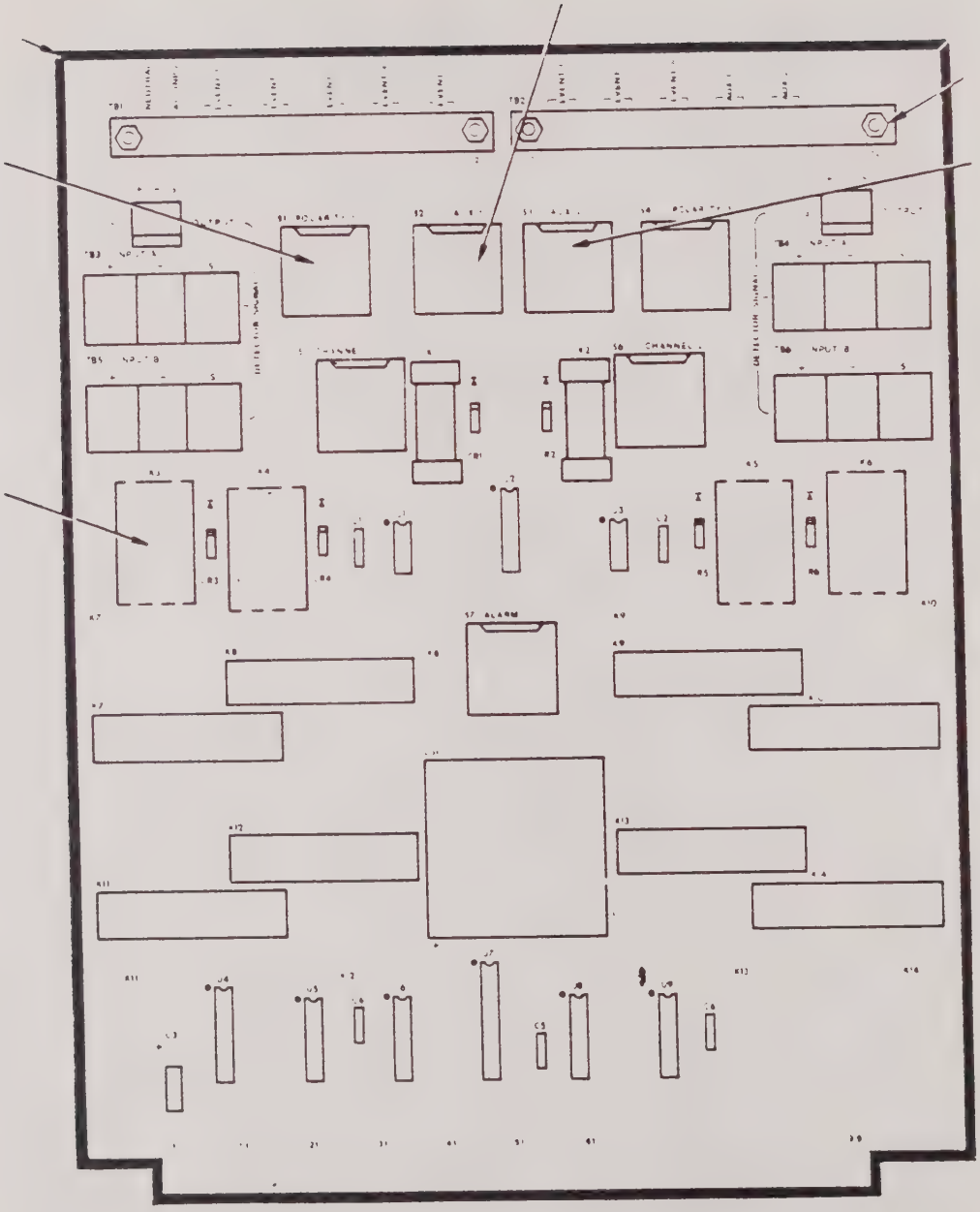
c. The 8 SSR's are each dedicated to a bit on the data bus while the other relays and alarm are programmable by seven 10 position thumbwheel switches.

d. The programming switches allow the detector polarity reversal, channel switching relays, two auxilary contact closures, and the audible alarm to be activated separately or simultaneously by any one of the 8 events.

e. Keypoints:

1. When the lower electronics cover is off the instrument for optional board trouble shooting, be sure the voltage interlock switch located in the lower corner in back of the electronics compartment is pulled out.

NOTES:



EXTERNAL EVENT PCB

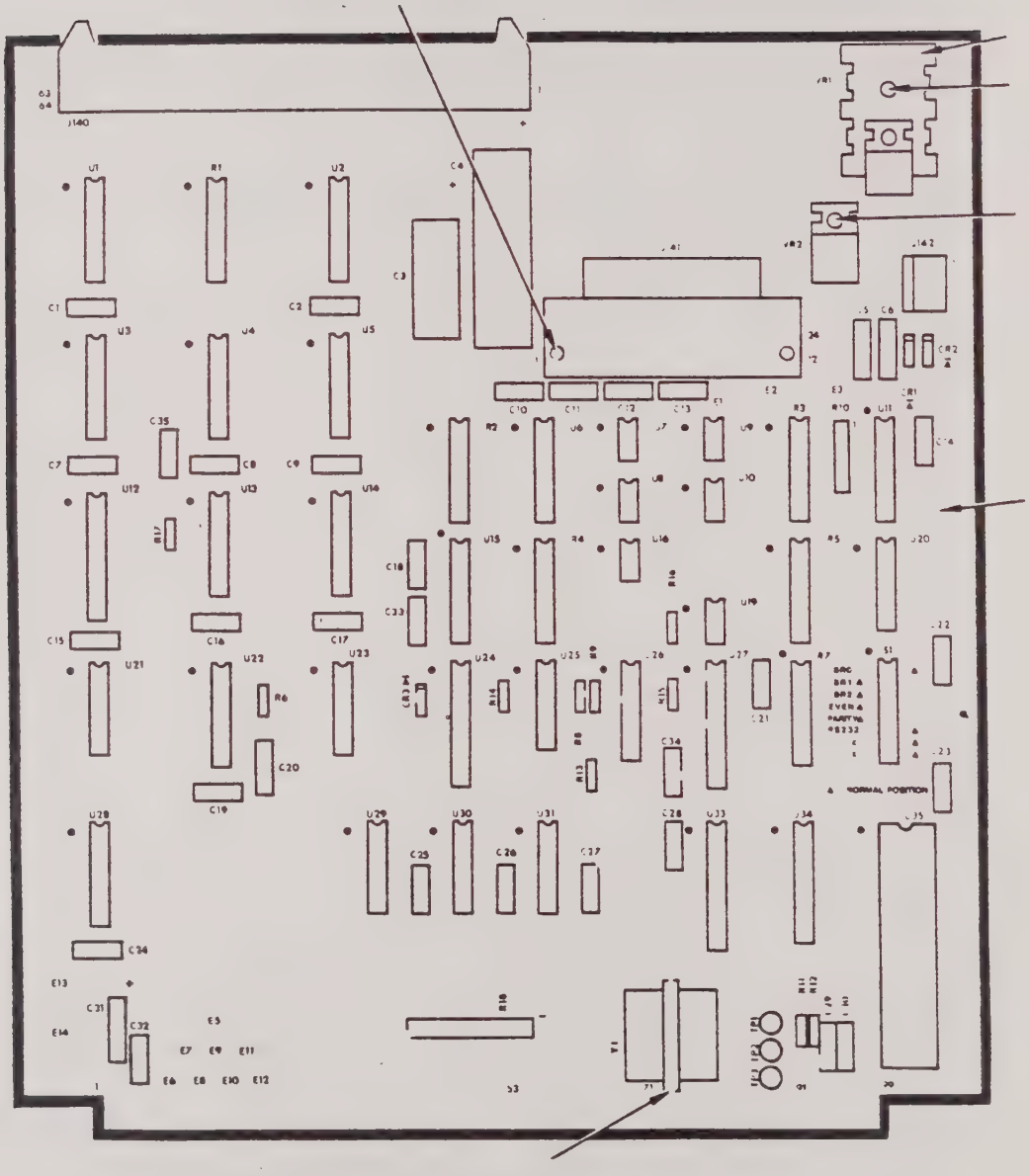
FIG. 9-8

9.10 PARALLEL/SERIAL INTERFACE PCB (optional) (Fig 9-9)

a. The Parallel/Serial interface is the link between the CDS-401/402 and the VISTA GC. Also this board is the link to the VISTA 6500. Any information going to the 6500 or coming from the CDS data system will go through this board.

b. Fuses F-6 and F-7 protect the Serial I/O board. No data system or 6500 communication can take place if one of these fuses are blown. Replace both if one is blown.

NOTES:



PARALLEL/SERIAL INTERFACE PCB FIG. 9-9

9.11 DETECTOR INTERFACE PCB (Fig 8-4)

a. All the data collected from the detectors will go through this board and out to the data processing equipment. This board has 1mv, 1v, and 10v outputs for A and B detectors. The 1mv recorder output is attenuated. The auto-zero is also turned on and off through this board. The mother board interconnect goes through this board.

b. Keypoints:

1. TCD filament current problems could be caused by the reference voltage set improperly.
2. Reversed peaks is also a symptom of reference voltage set improperly

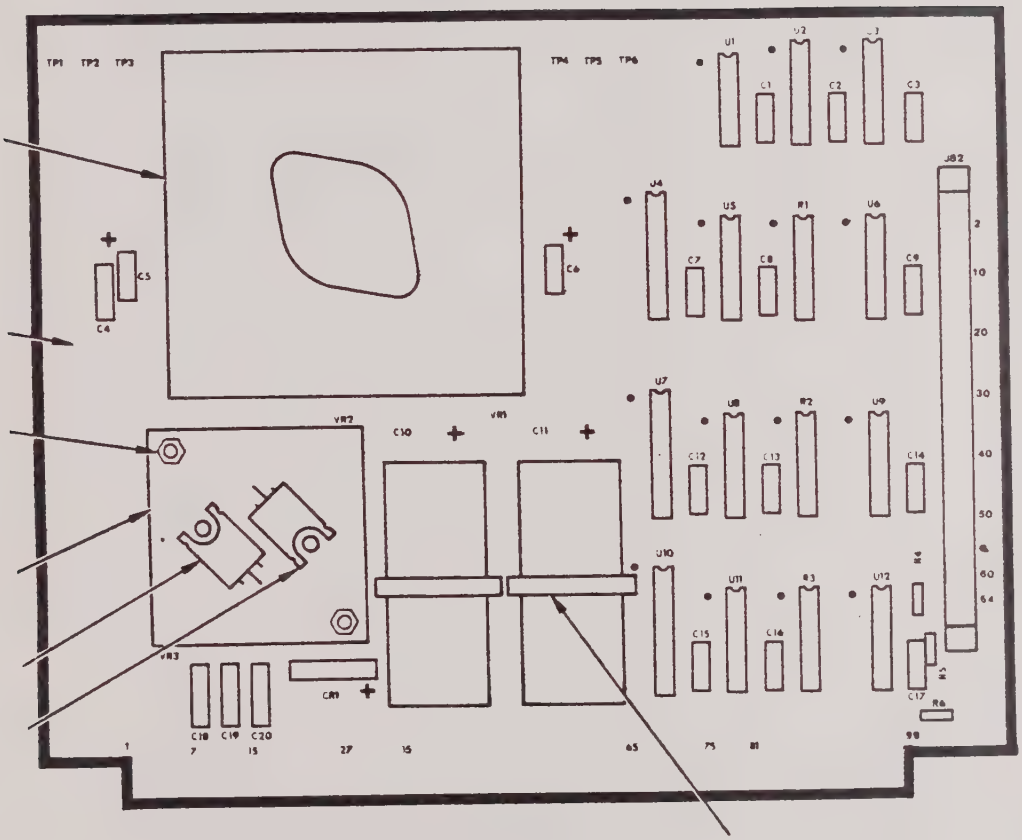
NOTES:

9.12 INTERCONNECT POWER PC BOARD (6500 only) (Fig 9-10)

a. Operation of the VISTA 6500 requires a CPU. The CPU used is shared from the 4600 or 6000 Series GC via the Parallel/Serial PCB to a flat Parallel cable to the Interconnect Power PCB.

b. When the connections are made the CPU automatically knows the 6500 is there and the 4600/6000 series GC will ask what instrument you want to program.

NOTES:



INTERCONNECT POWER PC BOARD FIG. 9-10

9.13 PROBE AMPLIFIER PCB (Fig 9-11)

a. All six thermal zones (inlet/or A/B, TCD and INJ bases, column oven and auxiliary zone) are monitored and checked against limits by the probe amplifier PCB

b. The analog probe outputs are converted to digital form and compared to control points in software so that the amount of control needed to hold a zone at the requested value is provided.

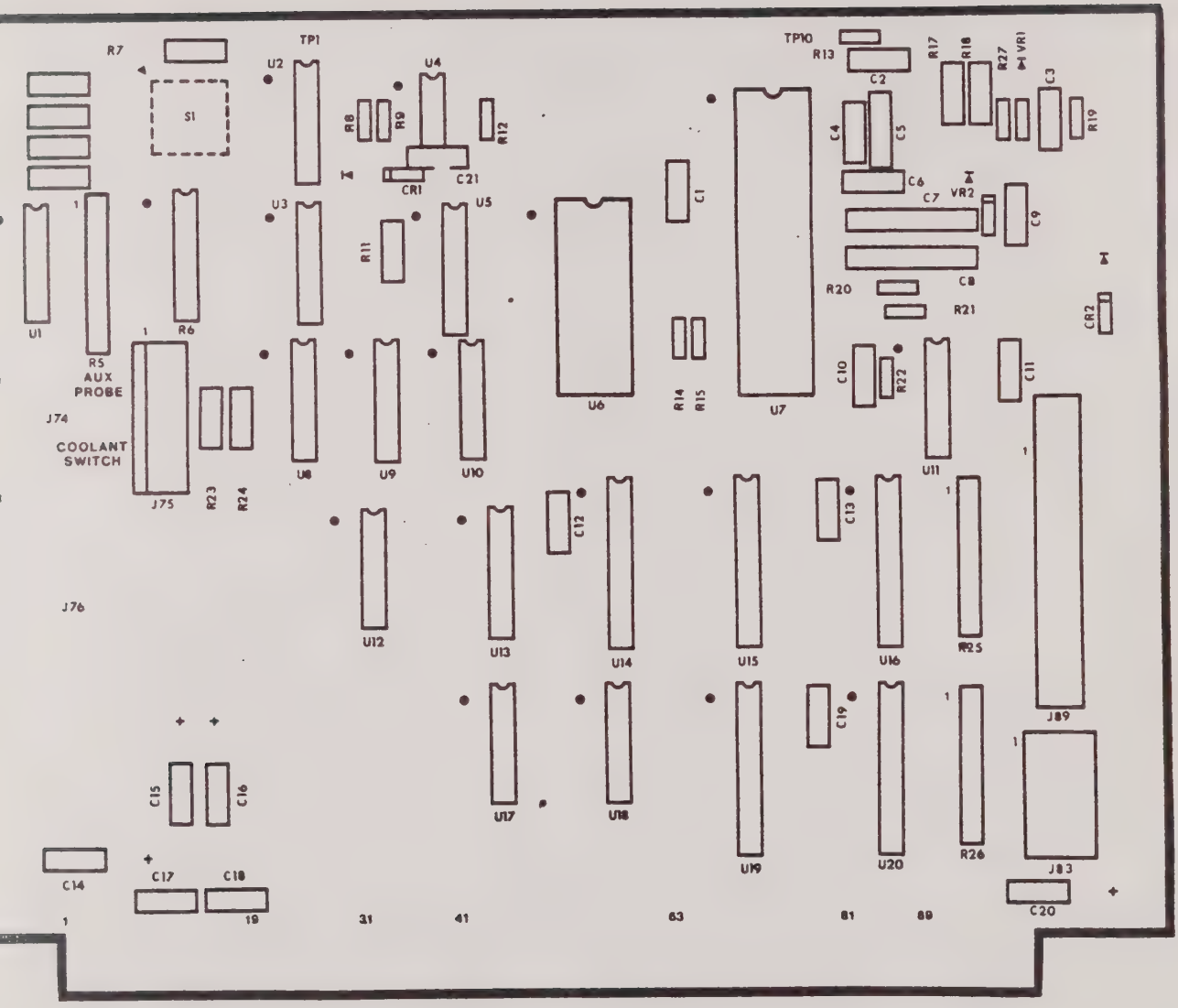
c. An additional circuit constantly checks for greater that 420°C temperature at any thermal zone. Should this take place the main contactor relay opens which removes power form all heater.

d. Additional circuitry on the PCB includes L20 and U16 which are data latches used to transfer signals from the Front Panel PCB (CRT, Keyboard and Interface) to the Vista 401/402.

e. The interconnect cable at J33 also interfaces the Vista 401/402 to the Front Panel PCB directly.

f. U16 is the system timer and generates the 30 msec real time interrupt.

NOTES:



PROBE AMPLIFIER PCB

FIG. 9-11

9.14 SSR POWER CONTROL PC BOARD (Fig 9-12)

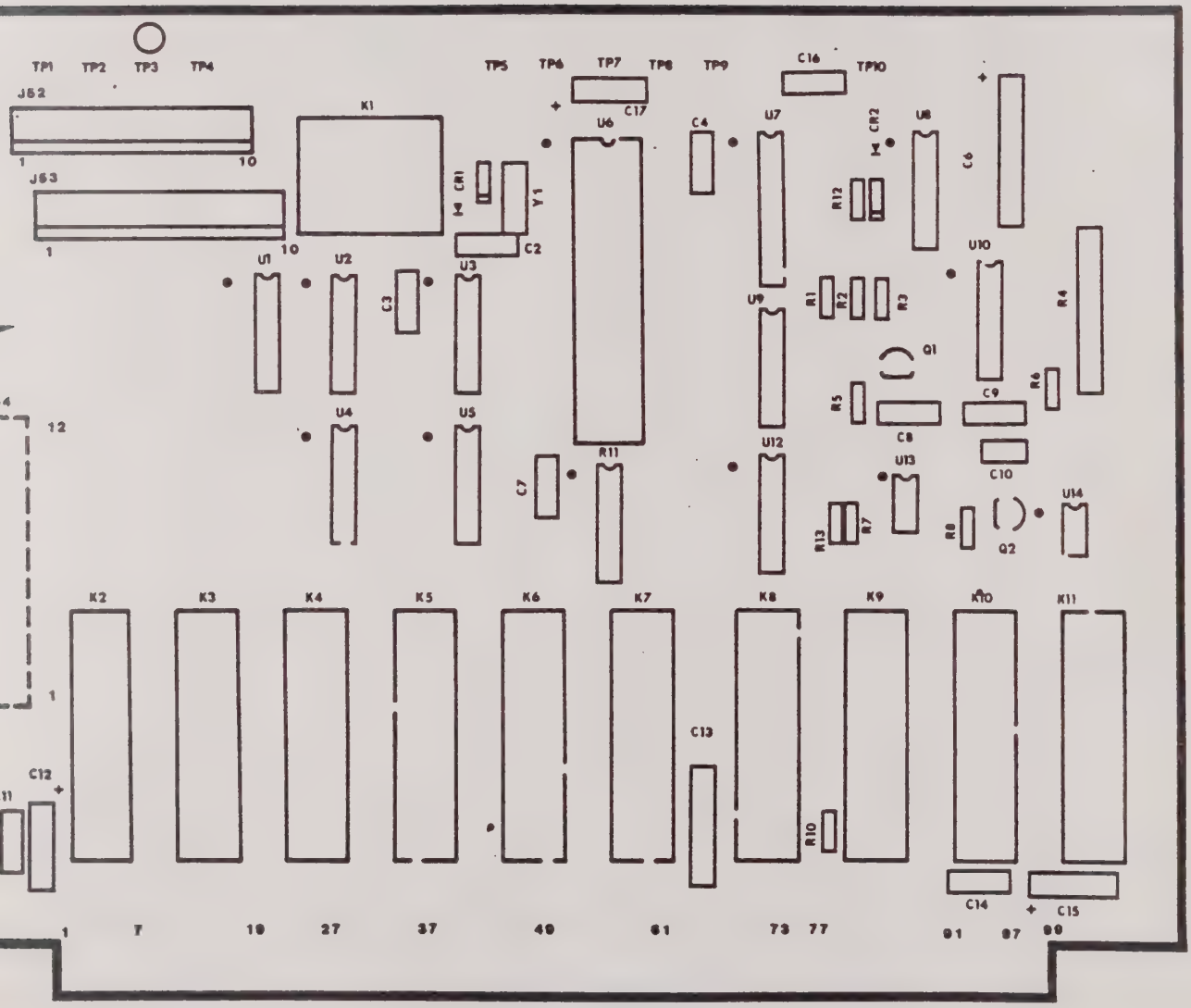
a. This board controls a series of Solid State Relays that, in turn control the application of 115VAC to the following:

1. Fan motor	2. Coolant Valve
3. Door Motor	4. Aux Heater
5. Pneumatics Heater	6. TC Detector Heater
7. ION Detector Heat	8. Injector A heater
9. Injector B Heater	

b. A zero crossing detector is used to control the column oven triac.

c. A slave CPU, actually a universal peripheral interface device, is used to control the heaters, etc.; however, it depends on the main microprocessor for control data.

NOTES:



SSR POWER CONTROL PC BOARD

FIG. 9-12

4. Detector tower not secured tightly.
5. Gas leaks.
6. Attenuation set at .1 instead of 1.

SPLITTER VENT (CAPILLARY) OR OTHER 115 VAC SOLENOIDS DO NOT ACTUATE:

1. Interlock switch open: Check to see that side panel is in place and secure.
2. Defective solenoids.
3. Defective external events PCB.

AUTOSAMPLER DOES NOT OPERATE OR STOPS AFTER PARTIAL RUN:

1. Check for Stop Pin.
2. Interlock switch open: Side panel off or not tightly secured.
3. If 401/402 is interconnected to 6000, both Autosampler methods should be set to inactive. (Meth Schd button).

APPENDIX A
LOADING THE SYRINGE

GENERAL COMMENTS

No hard and fast rules can be set down for syringe loading. Operators will develop a technique giving the most accurate and repetitive results. Whatever the method adopted, it must be consistent. Variability in syringe loading will most certainly result in variable results making accuracy suspect at best and impossible at the worst.

There are various syringe loading techniques: i.e., dry needle, wet needle, simplified injection, etc. However, experience has led us to recommend the "Sandwich Method" as the technique most conducive to accuracy and repeatibility.

Load the syringe by the "Sandwich Method" as follows for a 1 μl injection using a 10 μl syringe:

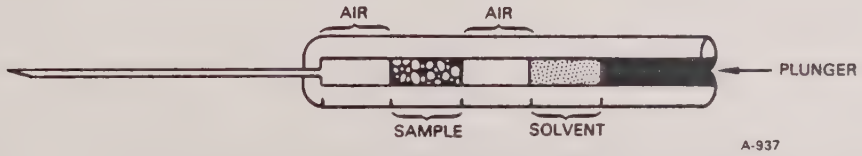
(1) Purge the syringe with pure solvent. Draw and eject several charges of solvent until liquid column appears free of bubbles.

(2) Remove needle from solvent. Draw air into the syringe by pulling the plunger back to the 1 μl mark on barrel. The liquid slug is needle hold up and may vary from .6 to .9 μl.

(3) Immerse needle in sample and draw plunger back from the 1 μl mark to the 2 μl mark on syringe barrel.

(4) Remove needle from sample solution. Draw plunger back until approximately 1 μl of air is between needle and sample slug.

(5) Confirm exact volume of sample with graduations on syringe barrel.



(6) Inject the sample. This technique leaves the needle with some solvent after the sample has been injected, therefore insert needle, inject sample, and withdraw the needle as smoothly, repeatably, and rapidly as possible.

This procedure, if followed consistantly, assures injection of a sample that is free of carry over contamination and accurately repeatable in volume.

SYRINGE LEAK CHECK

In some instances, non typical chromatographic responses can be attributed to a worn and/or leaky syringe. Liquid seen at the point where the plunger enters the barrel usually indicates poor fit between plunger and barrel bore.

Other defects to look for are:

(1) Fixed needle — leak due to loss of epoxy seal of needle to barrel.

(2) Replaceable needle — needle to barrel seal leaking.

(3) Mismatch of barrel and plunger. ***Never*** interchange syringe barrels and plungers. Plungers and barrels are ground and polished as a matching assembly and ***are not*** interchangeable.

(4) Cracked syringe barrel.

(5) Bent plunger.

To pressure test the syringe:

(1) Purge the syringe of gas bubbles by flushing with the solvent.

(2) Draw ~2 μl of solvent into the syringe barrel next to the plunger. Move the liquid plug to mid position in the barrel.

(3) Holding the plunger to prevent any movement, insert the needle into an injector at operating pressure.

(4) Observe the liquid plug. If the plug remains stationary over a 15 second period, the syringe is satisfactory. If the plug moves toward the back of the barrel and leaks around the plunger, the plunger to barrel seal is defective and the syringe should be discarded.

APPENDIX B
INJECTION TECHNIQUES

Injection techniques will vary due to column configuration, column design (packed or capillary), liquid phase loading, column internal dimension, etc. In addition to the examples described below, there will always be specific applications that require very specialized procedures that cannot be covered in this brief outline. The more common practices are described below.

(1) On column sample injection: (Preferable for most analytical determinations). Definition: By this injection method, the sample is delivered from the needle tip to a location just above (but not into) the column packing. Ideal conditions for this injection mode are:

(a) Sample size: 1-5 μl.

(b) Injection technique: needle insertion, sample injection, and needle withdrawal should be as fast, smooth, and repetitive as possible.

(c) Injector temperature: usually not more than 10-20°C above the column oven temperature.

(d) Injection technique: insert such that the needle tip stops just short of contacting column packing. Needle tip should penetrate the plug of glass wool packing retainer. Close attention to these procedures will prevent:

- plugged needles
- pulverized column packing, and provide;
- ample expansion volume to prevent sample backflash into the injector body.

(2) Flash vaporization: (used for preparative samples, samples that deposit residues ahead of column inlet). Definition: sample is discharged into a high temperature void space above the column, and vaporized before entering the packed portion of the column. Conditions for this injection method are:

(a) Sample size: 50-250 μl for preparative samples depending on available vaporization volume. 2-5 μl for samples that deposit residues.

(b) Injection technique: rapid needle insertion, relatively slow sample injection, and quick needle withdrawal.

(c) Injector temperature: typically 50-75°C above column oven temperature.

(d) Pressure control of carrier flow rate.

APPENDIX C
CHECKING FOR LEAKS

INTRODUCTION

There are three methods commonly employed for detecting leaks in the chromatographic system, i.e., (1) A pressure check of the overall system where the system is pressured and the regulator gauge observed for any drop, (2) The application of a commercial leak detection liquid (Snoop®) to all fittings, the leak being indicated by bubble formation. This method is not ideally suited to checking leaks in a heated system since the boiling solution can be confused with bubbles caused by leaks, and (3) "SNIFFING" at fittings with a light hydrocarbon gas such as butane obtained from butane cigarette lighters. This latter method is used when ultra sensitive detection is desired, and is particularly applicable for systems checked at high temperature.

CHECKING FOR LEAKS

(1) General pressure check. Leaks between supply and GC.

(a) Shut off air, hydrogen, and carrier flows at the control valves on the GC.

(b) Open cylinder valves and pressure each system to 60 psig at the cylinder regulator.

(c) Back off the regulator control and note any drop in pressure on the low pressure gauge.

(d) A noticable drop in a 10 minute period indicates a leak somewhere between the supply and the shut off valve.

(2) Pinpointing the leak.

(a) Check each fitting between supply and shut off valve with Snoop®. Use Snoop sparingly. A drop at each fitting is usually sufficient to detect a leak. Do not spatter exposed PC Boards and other components with the liquid.

(b) Tighten all fittings where leaks are found. Use back up wrenches and tighten fittings ***only enough to correct leaks.*** Do not twist or otherwise strain associated plumbing.

(c) If tightening fails to correct a leak, replace the ferrule. Occasionally ferrules or fittings have become so distorted, leaks are impossible to correct. Replace ferrules and/or fittings.

(3) Checking the total system (carrier gas) assuming all leaks between supply and shutoff valve have been corrected, the entire carrier gas pneumatics is now checked:

(a) Remove ionization detector.

(b) Install detector base blank-off plug.

(c) Pressurize to 60 psig.

(d) Seal off the carrier system by closing the ON-OFF valve.

(e) System should hold a minimum of 15 min.

(f) If pressure does not hold, use SNOOP to locate.

(4) Check to the injector only:

(a) Disconnect column from oven injector fitting and cap off the fittings.

(b) Remove injector nut and septum and install injector inlet plug assembly (Teflon plug and nut; P/N 16-000799-00).

(c) Open carrier shut off valve and pressure system to 60 psig. Check all fittings between the shutoff valve and the injector. Correct any leaks detected.

(5) Air/Hydrogen systems.

(a) Shut off air and hydrogen at the Air/Hydrogen control block.

(b) Pressure air and hydrogen systems to ~30 psig check for pressure drop after 10 minutes, and check all fittings between cylinder and Air/Hydrogen block. Correct any leaks.

NOTE: Minute air or hydrogen leaks between supply and shut off valves do not affect performance nor present a hazard. The air and hydrogen systems down stream of the control block operate at essentially atmospheric pressure and the possibility of leaks in this region is remote.

APPENDIX D
USING THE VOLT/OHMMETER (VOM)

Most general duty volt/ohmmeters of low to moderate cost are similar in design and use. Maximum measurable voltages may vary, but nearly all have multiple range scales and a selector switch used to choose the voltage range required or resistance (ohms).

Probes are color coded red (+) and black (-) and plug into the VOM at appropriately labeled female jacks. In most VOMS, test leads do not have to be switched on the VOM to alternate from voltage to resistance measurements.

Some important precautions to observe when using the VOM.

(1) ***Never*** apply probes to a "live" circuit (one in which measurable voltages are present) with the selector switch set for resistance measurements (ohms).

(2) Always select a voltage range that ***exceeds the maximum*** voltage to be measured.

(3) Observe proper polarity when making Vdc measurements. Positive lead to positive pole.

(4) Keep fingers away from bare probe tips during measurements.

Procedures:

(1) Set select switch on ohms x 1. Short the probe tips to each other and zero the needle.

(2) For simple continuity measurements, selector can remain on ohms x 1. For precise measurement of resistance, set selector to scale that exceeds expected reading. Example: to accurately measure a 90k resistor set selector to ohms x 100,000 etc.

(3) For voltage measurements, set the selector switch to the scale whose upper limit exceeds the voltage to be measured. Ground the negative test lead either on chasis ground *or* ground test point if given. Momentarily touch the positive lead to the "HOT" test point and check response of the VOM needle:

(a) If needle pins, select higher range. Range is too low, or voltage is much higher than expected.

(b) If needle barely moves off 0 (zero) select lower range.

NOTE: When measuring the 270 polarization voltage of the 6000 with a low impedance VOM the meter itself will load down the power supply causing a lower reading than the actual operating voltage: instead of 270 a reading of 255 will be observed, the polarity of the voltage will be determined by the mode switch selection on the electrometer.

APPENDIX E
COLUMN CONDITIONING/BAKEOUT

GENERAL

Two general terms are applied to column treatment i.e., preconditioning or *conditioning* which usually implies factory conditioning prior to shipping, or customer conditioning of a new or repacked column, and ***bakeout*** which refers to a periodic bakeout of a column at elevated temperatures to remove accumulated heavy ends (very high boilers). The two procedures differ since conditioning applies to new columns, where a bakeout applies to a column in routine application use.

(1) Conditioning a new column:

(a) Column inlet to injector outlet fitting (in column oven).

- if column is metal, let outlet end hang free.
- if column glass, it may be necessary (to avoid strain) to connect column to both injector and detector fittings, and remove detector.

(b) Adjust carrier flow (N_2) to about 30 ml/min.

(c) Check table for maximum allowable temperature for liquid phase of the column. Set column oven temperature for 20-25°C higher than the maximum temperature at which the column is to be operated ***but below*** the maximum temperature listed in the table.

(d) Condition the column at 250°C for 24 hours.

(e) Connect outlet to the detector inlet fitting.

NOTE: If the column is to be stored for any length of time *before* using, cap both ends.

(2) Column bakeout.

(a) Bakeout procedures, the column remains connected to the detector in order to generate a baseline. However, columns should be disconnected from electron capture detectors, and detectors dedicated to highly sensitive applications whose sensitivity may be adversely affected by high column bleed.

(b) Adjust carrier gas flow to about 30 cc/min.

(c) Set column oven temperature to 20-25°C above maximum temperature at which column is to be operated, but ***below*** maximum allowable temperature of column liquid phase. See table.

(d) Monitor strip chart. Bakeout the column until peaks cease to emerge and baseline stability is restored. (Cannot be observed if column disconnected from detector.)

ORDER NUMBER	LIQUID PHASE	MAXIMUM TEMP
82-001030-00	Apiezon L	300°C
82-001060-00	Bentone 34	200°C
82-001089-00	Bis 2-Ethoxyethyl Adipate	120°C
82-001095-00	Bis 2-Methoxy Ethyl Adipate	150°C
82-001100-00	(Bis(2-Methoxyethoxyl)Ethyl Ether	50°C
82-001115-00	Carbowax 20M	250°C
82-001120-00	Carbowax 20M TPA	250°C
82-001130-00	Carbowax 400	125°C
82-001145-00	Carbowax 600	125°C
82-001160-00	Carbowax 1000	150°C
82-001165-00	Carbowax 1500	175°C
82-001170-00	Carbowax 1540	175°C
82-001185-00	Carbowax 6000	200°C
82-001212-00	Dexil 300	500°C
82-001215-00	Dibutyl Maleate	50°C
82-001230-00	Didecyl Phthalate	125°C
82-001235-00	Diethylene Glycol Adipate (DEGA)	190°C
82-001245-00	Diethylene Glycol Succinate (DEGS)	190°C
82-001270-00	Diisodecyl Phthalate	175°C
82-001285-00	2,4 Dimethylsulfolane	50°C
82-001295-00	Dinonyl Phthalate	150°C
82-001330-00	Ethylene Glycol Adipate (EGA)	200°C
82-001316-00	Ethylene Glycol Succinate Methyl Silicone (EGSS-X)	225°C
82-001345-00	Ethylene Glycol Succinate (EGS)	200°C
82-001350-00	FFAP	250°C
82-001375-00	Hallcomid M-18-OL	150°C
82-001385-00	Hexamethylphosphoramide (HMPA)	50°C
82-001395-00	IGEPAL CO 880 (Nonyl Phenoxypolyoxyethylene Ethanol)	200°C
82-001475-00	β,β' Oxydiproprionitrile	100°C
82-001480-00	Phenyl Diethanolamine Succinate (PDEAS)	225°C
	Polyethylene Glycol (see Carbowaxes)	
82-001484-00	Polyethylene Imine	250°C
82-001485-00	Poly m-Phenyl Ether (5-ring)	250°C
82-001486-00	Poly m-Phenyl Ether (6-ring)	300°C
82-001488-00	Poly m-Phenyl Ether (High Polymer)	400°C
82-001500-00	Propylene Carbonate (1,2 Propanediol Cyclic Carbonate)	60°C
82-001510-00	Reoplex 400 (Polypropylene Glycol Adipate)	190°C
82-001520-00	Silicone, D.C. 200, 200 CS	200°C
82-001519-00	Silicone, D.C. 200, 500 CS	200°C
82-001522-00	Silicone, D.C. 200, 12,500 CS	250°C
82-001525-00	Silicone, D.C. 550	275°C
82-001540-00	Silicone (Fluoro) QF-1 (FS 1265)	250°C
82-001560-00	Silicone GE SF-96	250°C
82-001565-00	Silicone GE XE-60 (Nitrile Gum)	250°C
82-001574-00	G.C. Grade SE-30 (Methyl Silicone)	325°C
82-001575-00	Silicone Gum Rubber SE-30 (Methyl)	300°C
82-001580-00	Silicone Gum Rubber SE-52 (Phenyl)	300°C
82-001537-00	OV-1 (Methyl Silicone)	350°C
82-001538-00	OV-17 (50% Phenyl Silicone)	325°C
82-001541-00	OV-25 (75% Phenyl Silicone)	300°C
82-001539-00	OV-101 (Liquid Methyl Silicone)	350°C
82-001543-00	OV-210 (Trifluoropropyl Methyl Silicone)	275°C
82-001544-00	OV-255 (Cyanopropylmethyl Phenyl-methyl Silicone)	275°C
82-001551-00	OV-275 (Cyano Silicone)	250°C
82-001595-00	Squalane	100°C
82-001600-00	Squalane	140°C
82-001603-00	STAP (Steroid Analysis Phase)	255°C
82-001615-00	Tetracyanoethylated Pentaerythritol (TCEPE)	150°C
82-001638-00	Tributyl Phosphate	50°C
82-001655-00	1,2,3, Tris (2 Cyano Ethoxy) Propane (TCEP)	180°C
82-001813-00	Triton X-100	200°C
82-001660-00	Triton X-305	200°C
82-001675-00	UCON 50 HB 2000 Polar	200°C
82-001685-00	UCON LB 550X	200°C
82-001695-00	Versamid 900	250°C

APPENDIX F
Service Spares

Basic Cabinet

Part Number	Description
02-001891-00	Triac Assy.
19-000015-00	1a Fuse
19-000018-00	20a Fuse
19-000023-00	1.5a Fuse
10-000035-00	1/32a Fuse
19-000045-00	3a Fuse
43-399863-00	Line Filter
48-000101-00	Switch, Col. Oven
55-198994-00	Fuseholder
67-133440-00	4a Fuse
67-137450-00	5a Fuse
71-199938-00	Switch, Ignitor
71-299401-00	Push Switch
72-129850-00	Relay

Column Oven Parts

22-000059-00	Heater, Coil 110V, 750W
02-001880-00	Assy.Blower Motor
30-908106-00	Motor,115Vac 50/60 H_z 1550 RPM
30-000109-00	Motor 3.85 RPM (new)
18-000032-00	Fan Blade Col. Oven
18-000031-00	Fan, Inst. Cooling
02-001880-01	Fan Motor Mount Assy.

Injectors

Part Number	Description
01-001005-00	Injector Insert 1/4-1/8"
01-001007-00	1/4" Heated Injector
01-001008-00	1/8" Heated Injector
03-908196-00	Injector Heater & Probe
12-754014-00	Screw
16-000788-00	Septa Nut
69-000179-01	Septa (pd 25)
03-908127-00	Injector Nut

F. I. D.

01-000994-00	S/A Crossover F.I.D.
01-000996-00	Insert F.I.D.
03-908197-00	S/A Heater + Probe
02-001872-00	S/A Cathode
02-001873-00	S/A Anode
02-001876-00	Flow Tube Assy.
03-908263-00	Signal Cable
03-908264-00	Igniter Cable
12-142008-36	Screw, 8-32 x 2-3/4
15-003347-00	Washer 11/16 x .453 AL
16-000785-00	Nut,Flame Tip Mounting
21-000032-00	Insulator, Lower F.I.D.
27-403019-00	Viton "O" Ring
27-409195-00	Probe Seals
27-409281-00	"O" Ring,F.I.D.Cap Seal
37-000781-00	Collector
62-000199-00	Detector Base
89-999570-00	Vespel Ferrule
27-409195-00	"O" Ring Probe
02-001938-00	Flame Tip Assy. .020 Diameter
01-000996-00	1/4 - 1/8 Det. Insert

APPENDIX F

Pneumatics System

Part Number	Description
02-000315-00	1/4"-1/8" Swage Adapt.
02-001781-00	1/8" Graphite Ferrule, Brass Back Ferrule, Pk. 10
01-001047-00	Pressure Regulator
02-001906-00	Pressure Gauge Assy.
02-001907-00	Sampling Valve
02-001908-00	Cryogenic LN_2 Assy.
57-000286-00	Make-up Valve Assy.
16-000037-00	1/8" Swage Back Ferrule, Brass
16-000038-00	1/8" Swage Front Ferrule, Brass
27-109918-00	On-Off Valve
27-403019-00	Viton "O" Ring
27-590821-00	Particulate Filter
28-247054-00	1/8" Swage Cap, Brass
28-247071-00	1/8" Swage Plug, Brass
28-666599-00	1/8" Swage Bulkhead Un. Brass
28-696944-00	Swage T, Brass
28-691945-00	T-Fitting Swage
28-693989-00	1/8" Swage Nut, SS
28-693995-00	1/8" Swage Front Ferrule, SS
28-693998-00	1/8" Swage Back Ferrule, SS
28-694025-00	Swage Bulkhead Union, SS
28-694029-00	1/8" Swage Nut, Brass
28-694060-00	Swage Elbo Brass
28-694205-00	Swage Male Con. Brass
28-694302-00	1/8" Swage Union, Brass
03-908256-00	Gauge, Pressure 0-100 PSI
37-000126-00	1/8" Co]]er Tubing, 50'
37-000797-00	1/16" Tube Assy
68-000069-00	Line Filter, Injector
68-000070-00	Carrier Inlet Filter
79-000353-01	Flow Block
03-908146-00	Flow Controller, Porter
03-908099-00	Flow Controller, Condyne

APPENDIX F

4600/6000 Gas Chromatograph

Part Number	Description
03-905416-03	CRT/Key Interface
03-908553-00	RAM/ROM
03-908576-00	C.P.U.
03-908001-00	External Events
03-908005-00	Auto. Sampler
03-908121-00	Parallel-Serial
03-908037-00	Regulator (PowerSupply)
03-908029-00	Detector Interface
03-908060-00	TCD Power Supply
03-908064-00	TCD Electrometer
03-908108-00	ECD Electrometer
03-908025-00	FID Electrometer
03-908139-00	FPD Electrometer
03-908317-00	TSD Power Supply
03-908013-00	Probe AMP
03-908017-00	SSR Power Controller
03-908033-00	High Voltage
03-908238-00	Flow Sensor PCB
03-908009-00	Upper Mother Board
03-908209-00	Lower Mother Board
03-908101-00	Mass Flow Sensor
03-908045-00	Interface PCB
03-905532-00	Battery Charger Assy.
78-505000-00	CRT Assy.

APPENDIX F

CDS 401 Data System

Part Number	Description
03-907034-00	CRT/Key Interface
03-907019-00	RAM
03-907019-01	RAM
03-907019-02	RAM
03-907096-01	ROM
03-907023-00	CPU
03-907006-00	Disk Interface PC
03-907015-01	ADC/I-O
03-907039-00	Auto.Samp./External Events
03-907048-00	Power Supply
03-906202-00	Old Printer Plotter Controller
03-906353-00	New Printer Plotter Controller
03-906345-00	Old Print Head
03-906352-00	New Print Head
03-907238-00	Disk Drive
03-907118-00	CRT Assy.
03-907004-00	Mother Board
03-907175-00	+5 VDC Regulator

Remote Printer/Plotter

03-906282-00	Power Supply
03-906286-00	Attenuator/Paper Advance
03-906202-01	Old Printer Plotter Controller
03-906352-01	New Printer Plotter Controller

APPENDIX "G"

ELECTRICAL FAILURE IN ISOLATED ZONES

Electrical failure does not necessarily result in total instrument shutdown; it can be confined to isolated heated zones, i.e., open heater in Detector ovens, Injector ovens, or Column oven.

Before proceeding with circuit board removal, check the fuse or fuses associated with the defective components. Most of the isolated circuits are fused; always check the appropriate fuse before assuming that trouble lies elsewhere. Fig. 7-3 lists fuses, associated circuits and results of a blown fuse. Fig. 7-3 also shows the location.

Fuses F2 to F5 are located on the same panel as F4. Fuses F6 to F18 are located on a fuse panel mounted inside the cabinet just above the main power transformer.

Failure of the INJECTOR or DETECTOR oven to heat can often be traced to a defective sensing probe, a defective cartridge heater and/or a Probe amp circuit board and/or a power control (SSR) board. To isolate the problem, perform the following steps:

A. 4600

Do a Cold Start on the G.C.

(1) Turn the instrument main power off.

B. 6000/6500/4600B

Do a Cold Start on the G.C.

(1) Turn the instrument main power off

(2) Turn battery switch off

(3) Unplug AC cord from the wall outlet.

(4) Then plug AC cord back into wall outlet.

(5) Turn instrument main power on.

(6) Turn battery on.

(2) Push and hold reset key on instrument control panel.

(3) While pushing reset key, turn main power on.

(4) Release reset button

Check the injector and detector ovens on the C.R.T. for temperature presets.

(7) The temperatures should equilibrate to preset. If they do, try bringing them up to some operating set points. If they equilibrate, the problem could have been an electrical spike that was detected as an over temperature by the safety circuit and turned the power off to the heat zones.

Each Heater/Probe assembly is plugged to the Probe Amp and SSR PC Boards and can be checked as follows:

(1) Remove the snap-on cabinet injector covers.

(2) Remove the cover on the right side of the upper electronics bay (2 screws).

WARNING:

DANGEROUS VOLTAGES ARE EXPOSED WHEN POWER SUPPLY PROTECTIVE COVERS ARE REMOVED. DISCONNECT INSTRUMENT POWER BEFORE

PROCEEDING.

(3) Trace the Heater leads from the defective heat zone to the connector strip on the SSR PC Board. Disconnect the Molex connector and check for continuity across the contacts as shown in Figure 11-1.

(4) Trace the Probe leads from the defective heat zone to the connector strip on the Probe Amp PC Board which is next to the SSR board. Disconnect the Molex connector and check for continuity across the contacts.

NOTE:

SMALL LEADS ARE PROBE LEADS, AND THE HEAVY LEADS ARE HEATER LEADS.

If either probe or heater show an open circuit (infinite resistance, ∞) the assembly must be replaced.

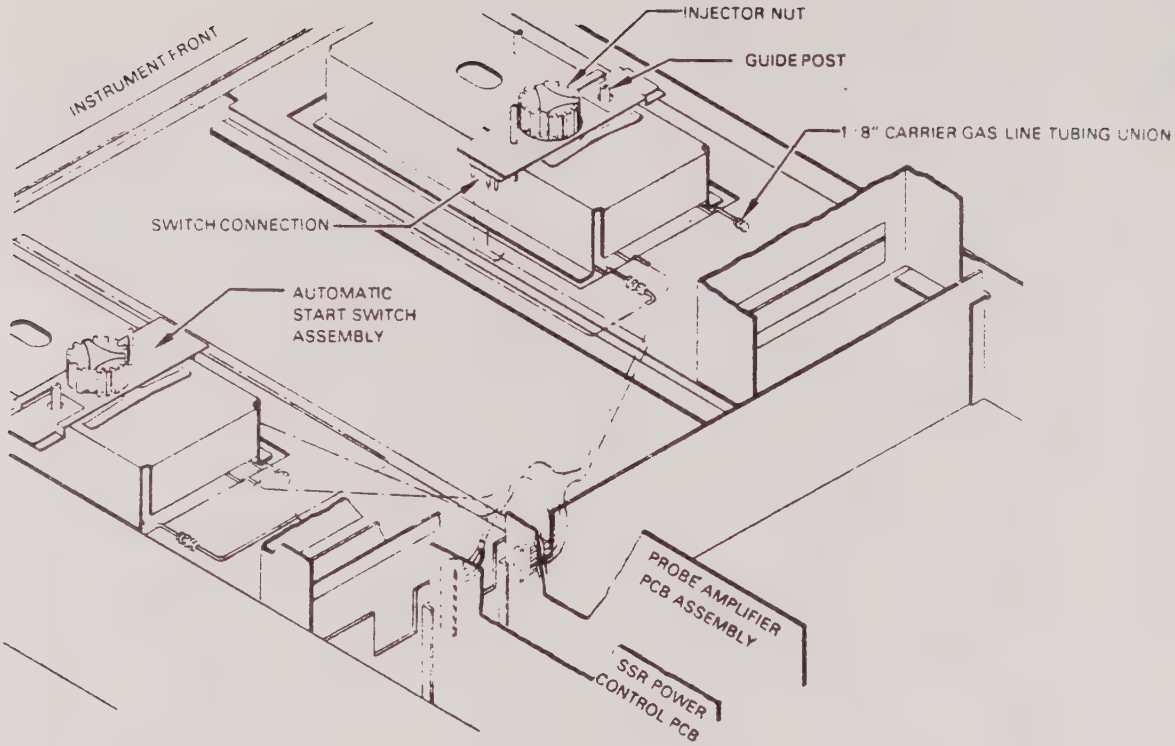
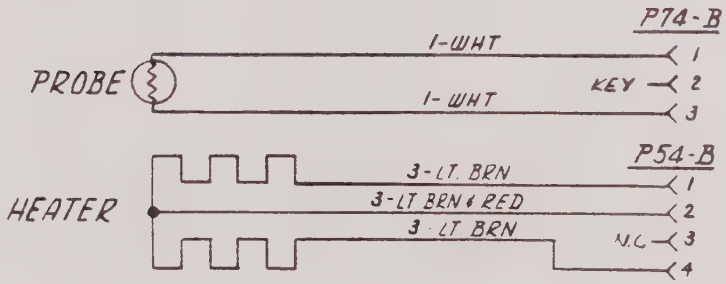
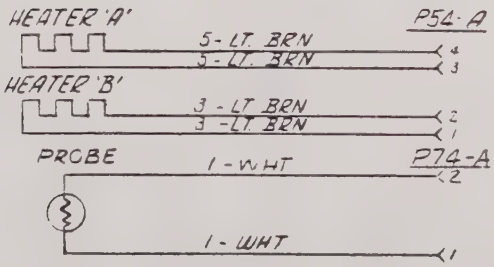

INJECTOR NUT
GUIDE POST
1/8" CARRIER GAS LINE TUBING UNION
INSTRUMENT FRONT
SWITCH CONNECTION
AUTOMATIC
START SWITCH
ASSEMBLY
PROBE AMPLIFIER
PCB ASSEMBLY
SSR POWER
CONTROL PCB

FIGURE 11-1


P74-B
PROBE
1-WHT
1
KEY
2
1-WHT
3
P54-B
HEATER
3-LT. BRN
1
3-LT BRN & RED
2
3-LT BRN
N.C
3
4


HEATER 'A'
P54-A
5-LT. BRN
4
5-LT. BRN
3
HEATER 'B'
3-LT BRN
2
3-LT BRN
1
PROBE
1-WHT
P74-A
2
1-WHT
1

APPENDEX "H"

REPLACEMENT OF INJECTOR OVEN HEATER/PROBE ASSEMBLY

Replacement of the Heater/Probe assembly requires removal of the injector oven block assembly as follows:

(1) Turn off Main Power switch. Disconnect instrument power cord from external power source.

(2) Turn off all instrument gases at pneumatics control panel. Remove all snap-on top cabinet covers. Remove column oven door and allow all heated zones to cool. Remove protective cover over the Probe Amp, SSR, and Hi-Voltage PC Boards on the upper right side of the instrument.

(3) Remove injector oven snap-on cover and insulation. Keep insulation intact for reinstallation.

(4) Disconnect the Heater cable from the SSR PC Board. Using a sharp "pick" carefully remove the appropriate heater lugs from the Molex connector by depressing the retaining tab on each gold-plated spring-connector. If necessary, ask your instructor to demonstrate.

(5) Disconnect probe connector from the Probe Amp PC Board and carefully remove the appropriate probe lugs from the Molex connector using the same sharp "pick" method. If you replace the heater/probe assemblies in both Injector A and Injector B, you will need to perform this step only for the probe-wire connections on the Probe-Amp PCB and not for the heater-wire connection. However, exchanging the spring-connectors is quicker and easier than replacing the

other injector's heater/probe assembly unnecessarily.

(6) Disconnect carrier gas line at tubing union (see Fig.11-2).

(7) Remove column.

(8) Remove four #8-32 mounting bracket screws securing injector oven block; then, remove oven block from cabinet.

(9) Remove heater and probe elements (part of Heater/Probe cable) from the oven (loosen clamping nuts if necessary). Install a new Heater/Probe assembly (P/N 03-908196-00). Be sure heater cartridge and probe are fully inserted into their respective wells. Tighten clamping nuts (Heater must be tightly clamped into injector assembly; if not, heater will over heat and burn out again).

REINSTALL INJECTOR OVEN ASSEMBLY AS FOLLOWS:

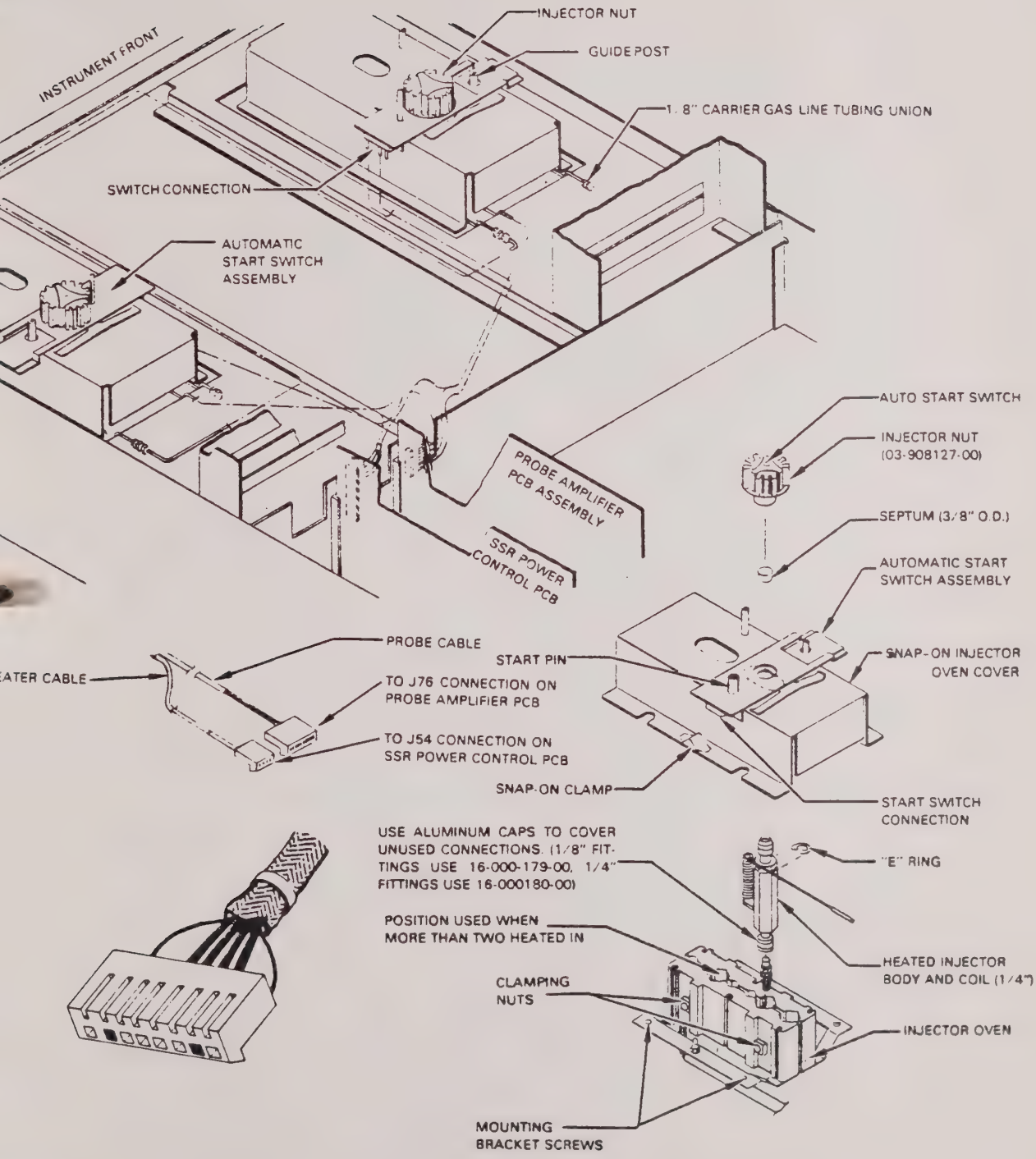
(1) Place injector oven in mounting position, route Heater/Probe cable between mounting bracket and oven (make sure cable is not pinched beneath mounting bracket), then tighten mounting screws (four places).

(2) Reconnect the carrier gas line. Plug in Heater and Probe cables to the appropriate Molex connectors on the SSR and Probe Amp PC Boards. Replace protective cover.

(3) Replace snap-on injector oven cover and insulation. Install new septum and septum nut. Replace all cabinet top covers. Install the column.

(4) Start carrier gas flow and leak check the union connected in Step 2. Tighten the union if a leak is detected.

FIGURE 11-2


INJECTOR NUT
GUIDE POST
1/8" CARRIER GAS LINE TUBING UNION
INSTRUMENT FRONT
SWITCH CONNECTION
AUTOMATIC START SWITCH ASSEMBLY
PROBE AMPLIFIER PCB ASSEMBLY
SSR POWER CONTROL PCB
AUTO START SWITCH
INJECTOR NUT (03-908127-00)
SEPTUM (3/8" O.D.)
AUTOMATIC START SWITCH ASSEMBLY
SNAP-ON INJECTOR OVEN COVER
START SWITCH CONNECTION
PROBE CABLE
EATER CABLE
TO J76 CONNECTION ON PROBE AMPLIFIER PCB
TO J54 CONNECTION ON SSR POWER CONTROL PCB
START PIN
SNAP-ON CLAMP
USE ALUMINUM CAPS TO COVER UNUSED CONNECTIONS. (1/8" FITTINGS USE 16-000-179-00, 1/4" FITTINGS USE 16-000180-00)
"E" RING
POSITION USED WHEN MORE THAN TWO HEATED IN
HEATED INJECTOR BODY AND COIL (1/4")
CLAMPING NUTS
INJECTOR OVEN
MOUNTING BRACKET SCREWS

APPENDIX "I"

REPLACEMENT OF TCD HEATER/PROBE ASSEMBLY

Any disassembly of the TCD oven by other than a Varian Service Engineer will void the TCD Warranty. Replacement of the TCD heater and probe assembly requires removing the entire TCD assembly from the instrument. DO NOT PROCEED WITH THIS INSTRUCTION IF YOUR INSTRUMENT IS STILL UNDER WARRANTY.

(1) Power down the GC; and unplug the power cord.

(2) Shut off all gas supplies

(3) Remove the three snap-on top covers. Remove the protective cover over the Probe Amp and SSR PC Boards in the upper right electronics bay.

(4) Allow all heated zones to cool sufficiently to avoid burns.

(5) Remove all columns and tubing that might be attached to the TCD inside the column oven.

(6) Disconnect the heater-wire connector from the SSR PC Board and the probe-wire connector from the Probe Amp PC Board (Fig. 11-3).

(7) Disconnect the gray signal cable connector from the TCD Power supply PC Board located in the upper left electronics bay (Fig. 11-3).

(8) Remove the four screws from the ceiling of the column oven which secure the detector inlet plate to the column oven top (Fig. 11-3).

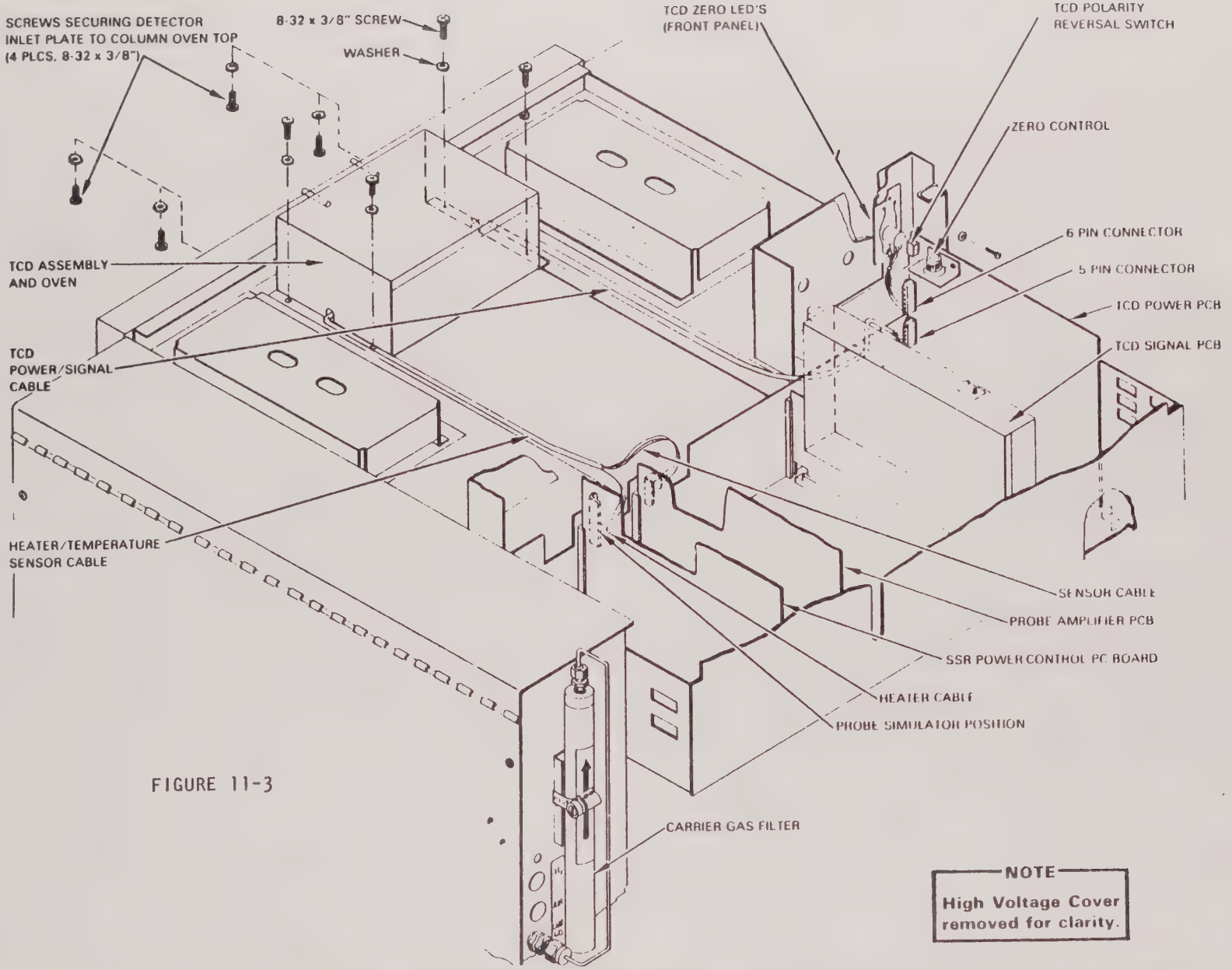


FIGURE 11-3

NOTE
High Voltage Cover removed for clarity.

(9) Remove the four #8-32 screws from the base of the black cover of the TCD assembly (outside the oven) which secure that cover to the instrument.

(10) Lift the entire TCD assembly free of the instrument trailing the signal cable and the heater/probe leads.

(11) When it is cool enough to touch, invert the TCD assembly, and remove the bottom piece of insulation (about 1-inch thick) by sliding it out from under the detector inlet plate.

(12) Remove the four screws which secure the lid to the sides of the cover, remove the lid and top piece of insulation.

(13) With the assembly upside down, lift the side cover off (feed the cables through gently).

(14) Unwrap the side insulation carefully. All insulation must be replaced!

(15) Remove the nut & screw which secures the heater/probe retainer to the TCD block, and withdraw the heater capsules -- the probe should slide out easily with the heaters.

(16) Install the replacement heaters and probe (P/N 03-908192-00) so that the heaters are approximately centered in the TCD block, and secure the retainer.

(17) Complete reassembly and installation of the TCD by reversing steps 16 through 2. Check for loose connections.

After checking to ensure safe operation, power up the GC, and test for proper operation.

APPENDIX "J"

REPLACEMENT OF ION OVEN HEATER/PROBE ASSEMBLY

The ion oven must be removed to replace the Heater/Probe assembly. Remove Ion oven block as follows:

(1) Turn off instrument power and disconnect power cord. Shut off all gas supplies. Remove all snap-on cabinet covers. Allow heated zones to cool. Remove protective cover over the Probe Amp, SSR, and Hi-Voltage PC Boards on the upper right side of the instrument (FIG. 11-4).

(2) Disconnect all columns from detector cross-over fittings inside the column oven.

(3) Disconnect the Heater connector from the SSR PC Board and the Probe connector from the Probe Amp PC Board.

(4) Carefully Remove any detectors that are installed on the two detector bases.

(5) Remove the screws securing the detector bases to the ion oven. Carefully lift the detector bases out of the ion oven and let them hang by the gas lines out of the way (FIG. 11-5).

(6) Remove the 4 screws that secure the ion oven assembly to the instrument. Raise the ion oven block from the instrument and invert it. Remove the piece of insulation where the leads enter the block. Locate the small allen set screw on the under side of the block and loosen. Withdraw the heater and probe as an assembly from the wells.

(7) Install the new Heater/Probe assembly making sure both

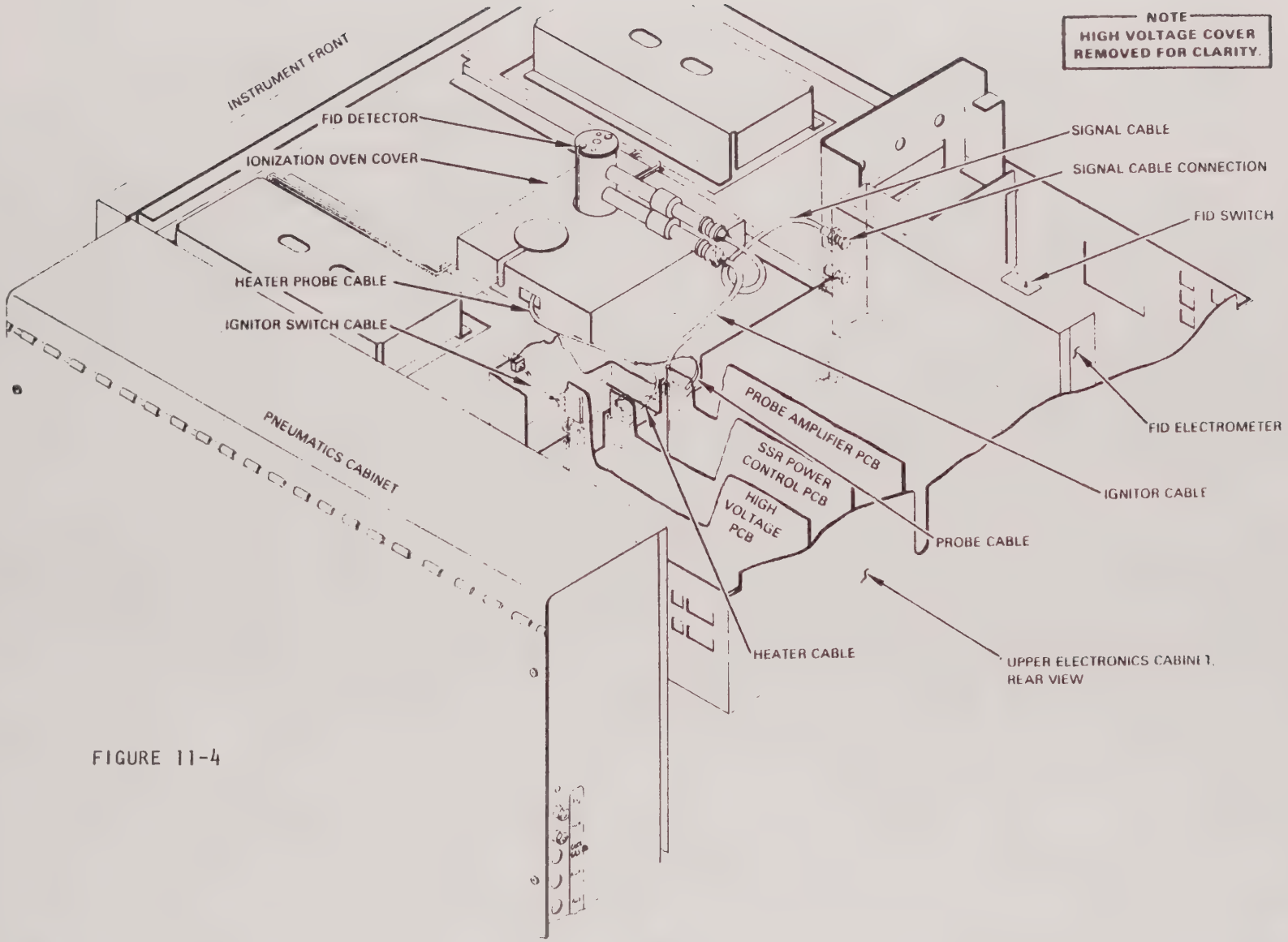

NOTE
HIGH VOLTAGE COVER REMOVED FOR CLARITY.
INSTRUMENT FRONT
FID DETECTOR
IONIZATION OVEN COVER
HEATER PROBE CABLE
IGNITOR SWITCH CABLE
PNEUMATICS CABINET
SIGNAL CABLE
SIGNAL CABLE CONNECTION
FID SWITCH
FID ELECTROMETER
PROBE AMPLIFIER PCB
SSR POWER CONTROL PCB
HIGH VOLTAGE PCB
IGNITOR CABLE
PROBE CABLE
HEATER CABLE
UPPER ELECTRONICS CABINET, REAR VIEW

FIGURE 11-4

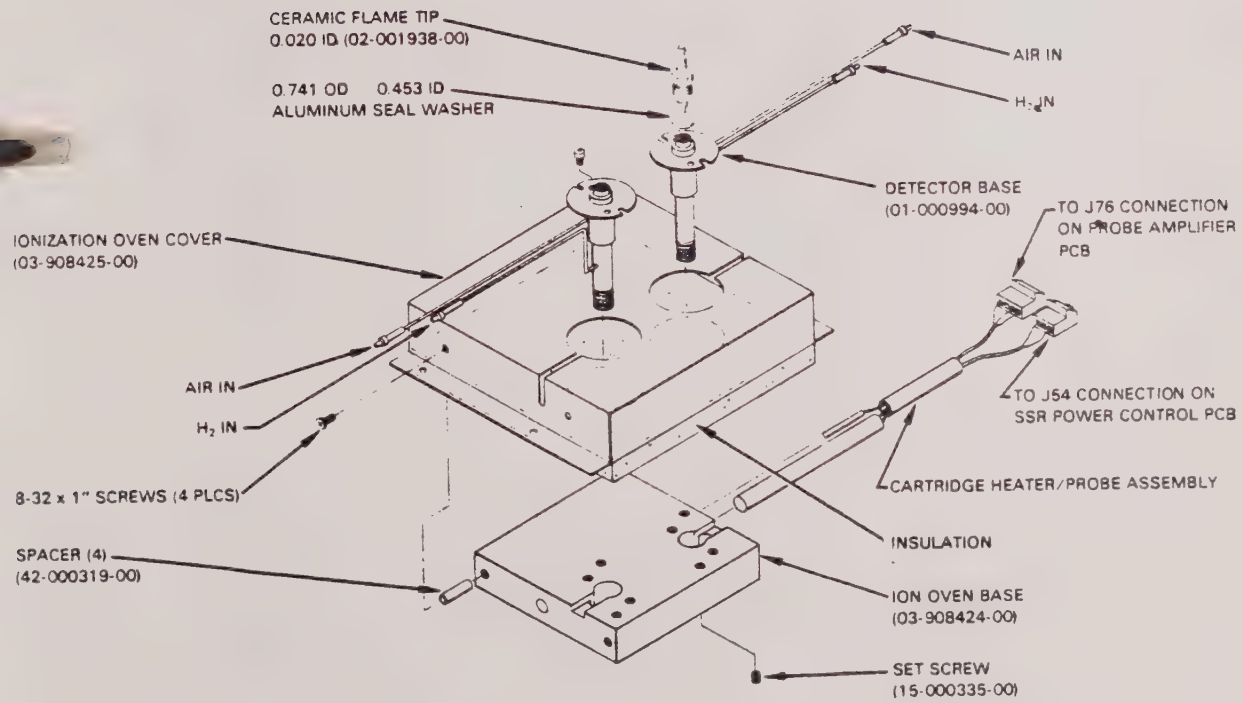

CERAMIC FLAME TIP
0.020 ID (02-001938-00)
0.741 OD 0.453 ID
ALUMINUM SEAL WASHER
AIR IN
H2 IN
DETECTOR BASE
(01-000994-00)
TO J76 CONNECTION
ON PROBE AMPLIFIER
PCB
IONIZATION OVEN COVER
(03-908425-00)
AIR IN
H2 IN
8-32 x 1" SCREWS (4 PLCS)
TO J54 CONNECTION ON
SSR POWER CONTROL PCB
CARTRIDGE HEATER/PROBE ASSEMBLY
INSULATION
SPACER (4)
(42-000319-00)
ION OVEN BASE
(03-908424-00)
SET SCREW
(15-000335-00)

FIGURE 11-5

probe and cartridge heater are inserted to the full depth of the wells. Tighten the set screw to secure the cartridge heater. Replace the insulation and reinstall the oven.

(8) Reinstall the detectors, and all electrical connections to the SSR, Probe Amp and High Voltage Psu (FIG. 11-4).

APPENDIX "K"

COLUMN OVEN PROBE REPLACEMENT

(1) Disconnect the Molex connector on the Probe Amp PC Board. Using a sharp "pick" carefully remove the column probe lugs from the Molex connector by depressing the retaining tab on each gold-plated spring-connector. If necessary, ask your instructor to demonstrate.

(2) Loosen the clamp behind the injector B oven and remove the old probe.

(3) Install the new probe. Probe should protrude about 1" past sleeve into the column oven.

(4) Reinstall the probe lugs into the molex connector (top two positions), and plug the Molex connector back into the Probe Amp PC Board.

APPENDIX "L"

COLUMN OVEN DOES NOT HEAT

(1) Check FAN-OFF-HTR&FAN switch on upper right panal of the unit. Switch must be in HTR&FAN position to enable the heater circuitry (Pressed to right).

WARNING: HAZARDOUS VOLTAGES EXPOSED WHEN REAR COVER IS REMOVED. BE SURE INSTRUMENT POWER IS OFF AND POWER CORD IS DISCONNECTED FROM POWER SOURCE.

(2) Remove the rear cabinet cover and check terminals 1, 3, and 4 on TB 11 (the terminal barrier strip located under the fan motor on the left bulkhead (FIG. 11-6) for continuity. If the column heaters are open or shorted, call a Varian Service Representative.

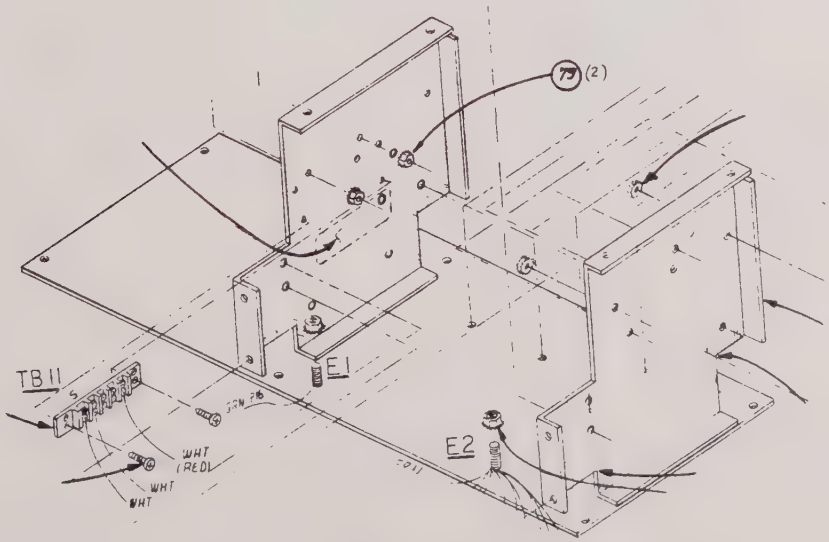


FIGURE 11-6

APPENDIX "M"

RUN AWAY TEMPERATURE -- INJECTOR, DETECTOR, COLUMN

A run away temperature is indicated when the temperature in a heated zone rises above that set on the CRT. The fault can usually be traced to a defective Probe/Amp, or SSR P.C. Board.

This problem will usually be indicated by a Partal shut down (D.C. Contactor open) and no heat will reach any zones. To detect an overheating problem, switch the instrument power off and then on again and watch the instrument CRT closely for temp SET points and also listen for the contactor to close and then open again!

(1) If all zones are over heating, the problem is probably the PROBE/AMP P.C. Board and should be replaced.

(2) If all zones are high and the oven door is cycling, the problem is the SSR P.C. Board and should be replaced.

(3) If just one zone is high, the problem is probably the SSR P.C. Board.

(4) If the column oven is the problem zone and replacement of the Probe/Amp and SSR P.C. Boards do not solve the problem, a shorted column oven triac is the probable cause and should be replaced.

APPENDIX "N"

CHECK ALL TEMP ZONE SET POINTS:

Protection circuitry will cause heat zones to shut off when protection limits are exceeded. See FIG. 11-7; i.e., run-away condition or SET POINT is too high. If for any reason the actual temperature exceeds the maximum permissible value, all temperature zones will be shut off.

If the indicated temperature of any heated zone exceeds the SET POINT and does not decrease at a preset rate, all temperature zones will shut down. If an individual temperature zone is below the required setting and is not increasing, only that affected temperature zone will shut down.

MAXIMUM PERMISSIBLE SETTINGS

Temperature Zones	Range	Maximum Permissible Settings
Temp. Control Inj. A, Inj. B	20° - 420°C	420°C
Temp. Control TC Det	Ambient - 420°C	420°C
Temp. Control ION Det.	Ambient - 420°C	420°C NOTE: Use graphite ferrule on flame jet for FID operation above 350°C. See FID Manual
Column Temp.	-99° - 420°C	Final Temp. 420°C; Column Limit 420°C; however, final temp. must not at any time be set higher than Column Limit
Column Limit	Column Limit 50°C-422°C	

FIGURE 11-7

APPENDIX "C"

FLAME IGNITOR Failure

(1) Check gas flows in ml/min, H2=30, Nitrogen, Linear gas 25-30. (Be sure gas lines are sufficiently purged, particularly the H2 line.)

(2) Check fuse F-11 (FIG. 7-3).

(3) Pull lower probe (coil voltage probe) from tower. Watch ignitor filament while actuating the ignitor switch. Try both A and B ignitor switch positions to check for crossed wiring. Coil should glow red after a few seconds.

(4) If coil fails to glow, remove probe and check for continuity.

(5) If coil is defective replace coil; voltage probe.

(6) If coil is not defective, the problem could be in the Hi-Voltage PC Board. Check the sensor cable connections, try for connections.

(7) Replace the Hi-Voltage PC Board, or call your Service Representative.

Category "B"

Power up --- NO disk

This malfunction is indicated when the microcomputer power is on, but heater zones fail to pulse (i.e. in case the overheating circuitry has caused all heat zones to shut off but has not caused a power down situation; therefore, those defects causing power down can be ruled out. Some possible causes for this failure may be an open heater element or a defective CPU, RAM/ROM, INTERRUPT CONTROLLER, OR PARALLEL/SERIAL P.C. BOARDS. To isolate the difficulty, proceed to the procedures outlined in Appendices K through M.

APPENDIX "Q"

LED DISPLAY CHECK

The front panel LED display will indicate the correct functions on "power up" of the CPU, RAM/ROM+ Interface/ Controller and the PARALLEL/SERIAL P.C. Boards. Also, it will show malfunctions of these boards, depending on which LED's are lit. The "NOT READY" A + B and the "AUTOZERO" A + B LED's are the only indicator which should be on during power up. If any LED's flash or if all LED's are off, there is an error (see figure 8-6).

APPENDIX "R"

LOGIC LEVEL CHECK

If after repeated Cold Starts the trouble observed is a continued failure to heat one or more zones, do a Heater/Probe Logic Level Check as follows:

(1) Turn off instrument power, and disconnect power cord.

(2) Remove the cover over the Probe A+B PC Board to the upper right electronics bay.

(3) Set your DVM to Direct Current Voltage on a range of 15 Vdc. Connect the Red probe to TP2 (Logic level of 5 Vdc + 5 Vdc) and the black probe to TP9 (Reference ground) on the Probe A+B Board (FIGURE 8-8).

(4) Connect the instrument power cord, and do a Cold Start.

(5) If the meaning measures nearly 0 Vdc, the [illegible]

Power is applied and the C.P.U. is all right. Check the system and error messages. If the reading remains [illegible] the problem is one of the above PCB's.

APPENDIX "S"

Heater Lead Check

An open heater element and/or probe, or a loose lead will cause heating failure in all zones without causing a blown fuse in instrument power cord. Check all heaters and sensor heater and probe leads for continuity.

(1) Remove top cabinet covers and the black protective cover on the right side of the upper electronics compartment covering the Probe/Amp and SSR P.C. boards.

(2) Disconnect the Molex connector of the suspected defective zone from the SSR P.C. board and check the heater lead contacts for continuity. Also check the probe leads on the Probe/Amp PCB.

(3) Tug gently on the leads to be sure they are securely crimped in place.

(4) If the leads do not have a measurable resistance of 100 ±10 ohms, then the heater element is burned out and must be replaced.

(5) Abnormally high resistance can indicate corrosion, dirt or poor contact in the Molex connector.

(6) A very low resistance reading indicates a shorted heater element. Check for frayed insulation on heater leads. Connectors become seldom cause intermittent

(7) If none of the above readings are found on the P.C. or one zone is not heating, (or) you suspect a bad probe if all zones do not heat.

APPENDIX "T"

RECORDER CHECK

(1) Short input terminals and check the recorder for mechanical and electrical zero.

(2) Reconnect signal input leads.

(3) Check fuse 8 (F8) on GC rear fuse panel.

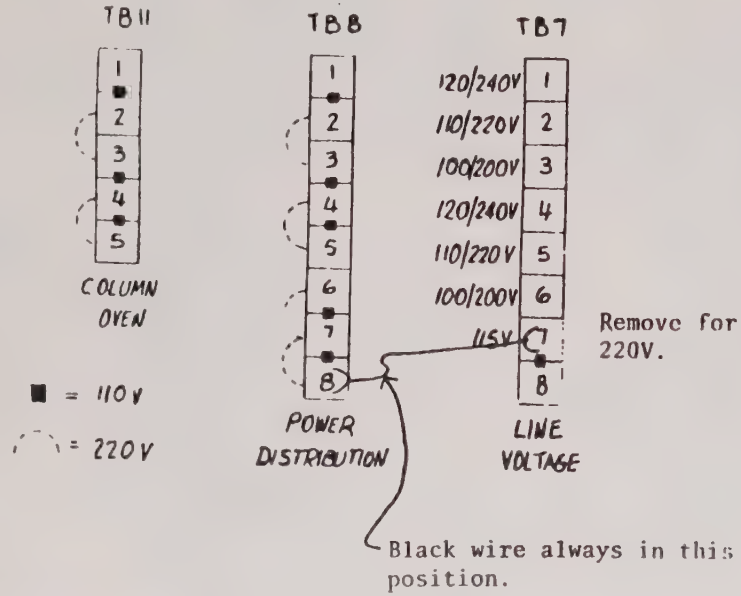
APP[illegible] U

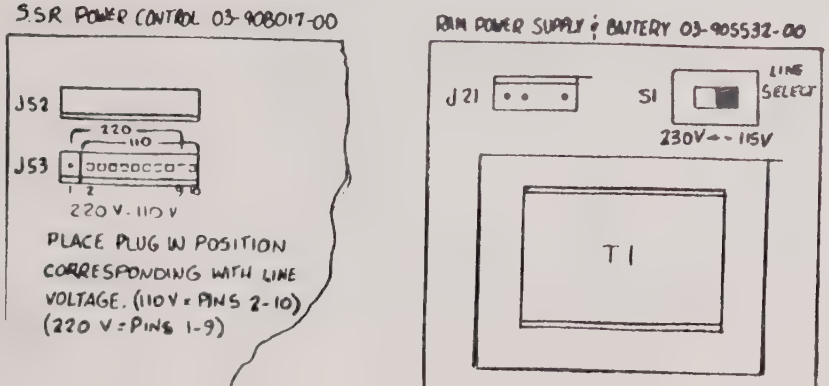
To c[illegible]rt between 110 VAC (-00) to 220 VAC (-01):

a) Remove all solid jumpers on "TB7", "TB8", "TB11" and install dotted jumpers.

b) Move jumper plug on SSR Power Control PCB to the 220V position.

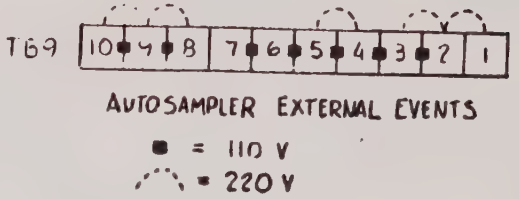
c) Change switch on RAM power supply and battery PCB (S1) to 230V position.





POWER LINE, TRANSFORMER TAP DATA

Do not convert "TB9" from 115V to 220V unless the [illegible] order outlets at the rear of the instrument are changed from 110V type to 220V type. "TB9" may remain in the 110V configuration when the line voltage is 220V. To convert "TB9" from 110V to 220V, remove all solid jumpers on barrier strip and install dotted jumpers.

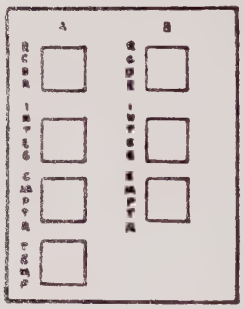


*Change 20 amp main power fuse to 10 amp for 220V.

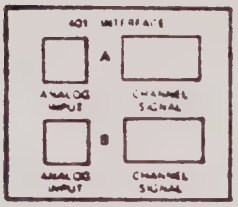
*Change 8 amp transformer fuse to 4 amp for 220V.

*See print 03-908200-00, sheet 2 of 8.

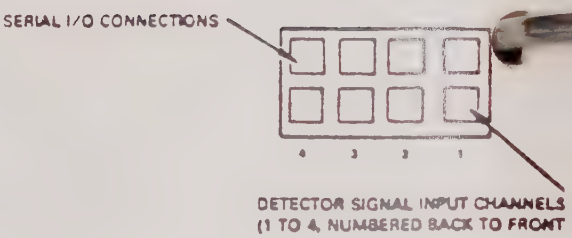
DETAIL A
PERIPHERIAL INSTRUMENT CONNECTORS

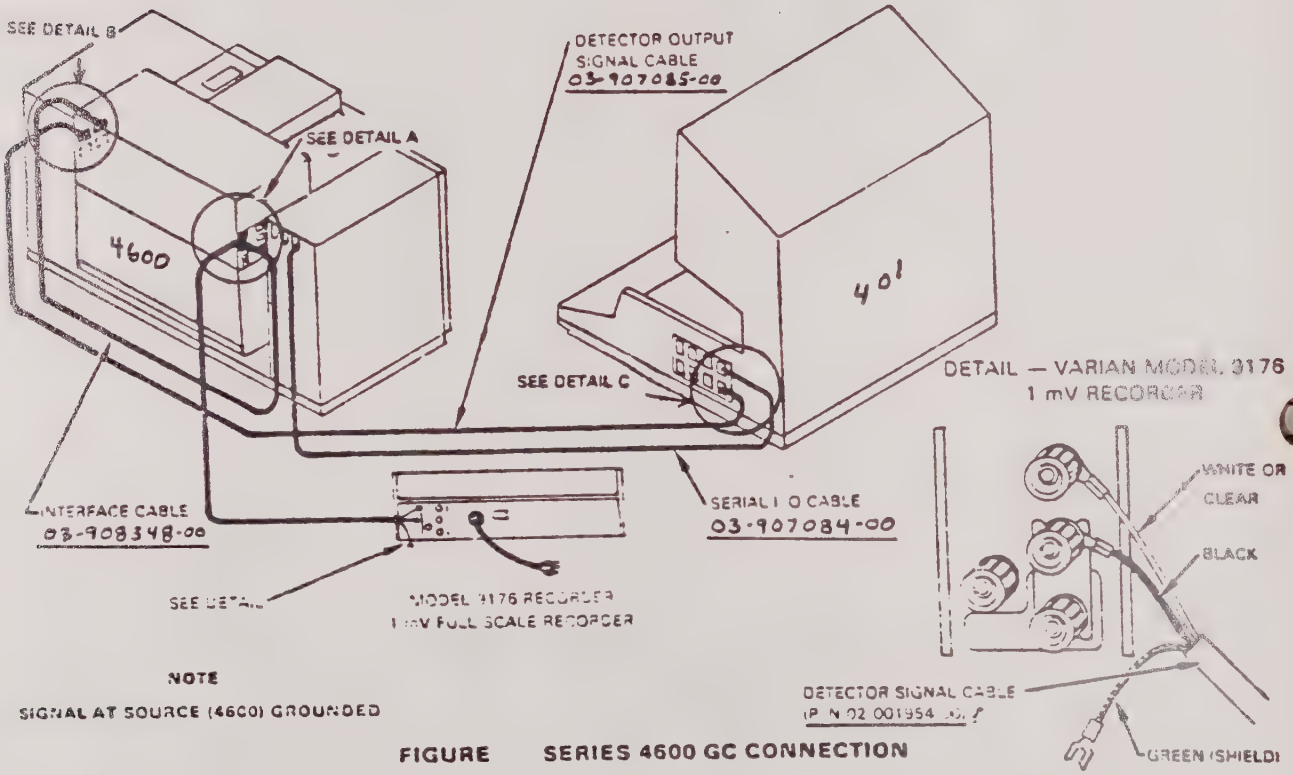


DETAIL B
DATA SYSTEM CONNECTORS



DETAIL C
VISTA 401 SIDE PANEL



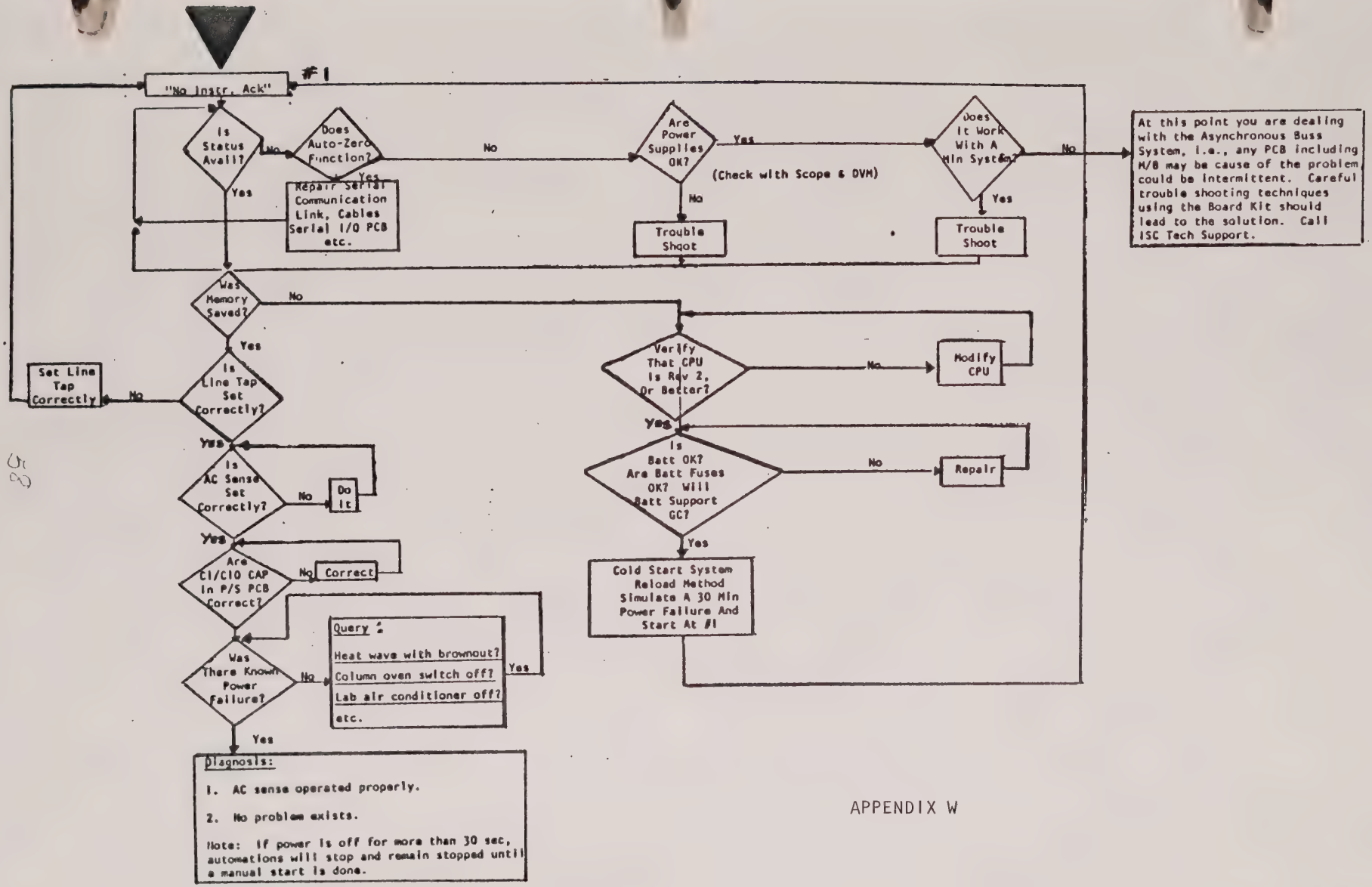


NOTE
SIGNAL AT SOURCE (4600) GROUNDED

FIGURE SERIES 4600 GC CONNECTION

FOR MORE DETAILED INFORMATION, REFER TO PRINTS 00-464010-00 AND 00-460000-00.

APPENDIX V


#1
"No Instr. Ack"
Is Status Avail?
No
Yes
Does Auto-Zero Function?
No
Yes
Repair Serial Communication Link, Cables Serial I/O PCB etc.
Are Power Supplies OK?
(Check with Scope & DVM)
Yes
No
Trouble Shoot
Does It Work With A Min System?
Yes
No
Trouble Shoot
At this point you are dealing with the Asynchronous Buss System, i.e., any PCB including M/B may be cause of the problem could be intermittent. Careful trouble shooting techniques using the Board Kit should lead to the solution. Call ISC Tech Support.
Was Memory Saved?
No
Yes
Verify That CPU Is Rev 2, Or Better?
No
Modify CPU
Yes
Is Batt OK? Are Batt Fuses OK? Will Batt Support OC?
No
Repair
Yes
Cold Start System Reload Method Simulate A 30 Min Power Failure And Start At #1
Is Line Tap Set Correctly?
No
Set Line Tap Correctly
Yes
Is AC Sense Set Correctly?
No
Do It
Yes
Are CI/CIO CAP In P/S PCB Correct?
No
Correct
Was There Known Power Failure?
No
Query :
Heat wave with brownout?
Column oven switch off?
Lab air conditioner off?
etc.
Yes
Yes
Diagnosis:
1. AC sense operated properly.
2. No problem exists.
Note: If power is off for more than 30 sec, automations will stop and remain stopped until a manual start is done.

APPENDIX W

MAINTENANCE AND TROUBLESHOOTING OF THE 6000 G.C.
COURSE EVALUATION

The Varian Training Department would appreciate an honest evaluation of the course you have just completed. We would like you to take a few minutes to fill out this form, which will then be used to improve the course.

	More Material	About Right	Less Material	Delete
LECTURES:				
Chromatographic Maintenance	( )	( )	( )	( )
Why? _____				
Electronic Maintenance	( )	( )	( )	( )
Why? _____				
LABORATORIES:				
Chromatographic Maintenance	( )	( )	( )	( )
Why? _____				
Electronic Maintenance	( )	( )	( )	( )
Why? _____				

ADDITIONAL COMMENTS:

_____

_____

_____

_____

_____

Please rate the instructors on a scale of 1 to 10 where 1 = Poor, 4 = Fair, 7 = Good, and 10 = Outstanding. Please include comments where necessary to help instructors improve their presentations (knowledge, attitude, clarity, helpfulness, etc.).

INSTRUCTOR'S NAME: _____ RATING: _____

Comments: _____

_____

_____

_____

MAINTENANCE AND TROUBLESHOOTING OF THE 6000 G.C.
COURSE EVALUATION

INSTRUCTOR'S NAME: _____ RATING: _____

Comments: _____

_____

_____

_____

INSTRUCTOR'S NAME: _____ RATING: _____

Comments: _____

_____

_____

_____

HOW DID YOU LEARN ABOUT THE COURSE:

1. Varian Representative _____
2. Varian Mailers _____
3. VIA Magazine _____
4. Work Associate _____
5. Other _____

MP MASTER
MA35187